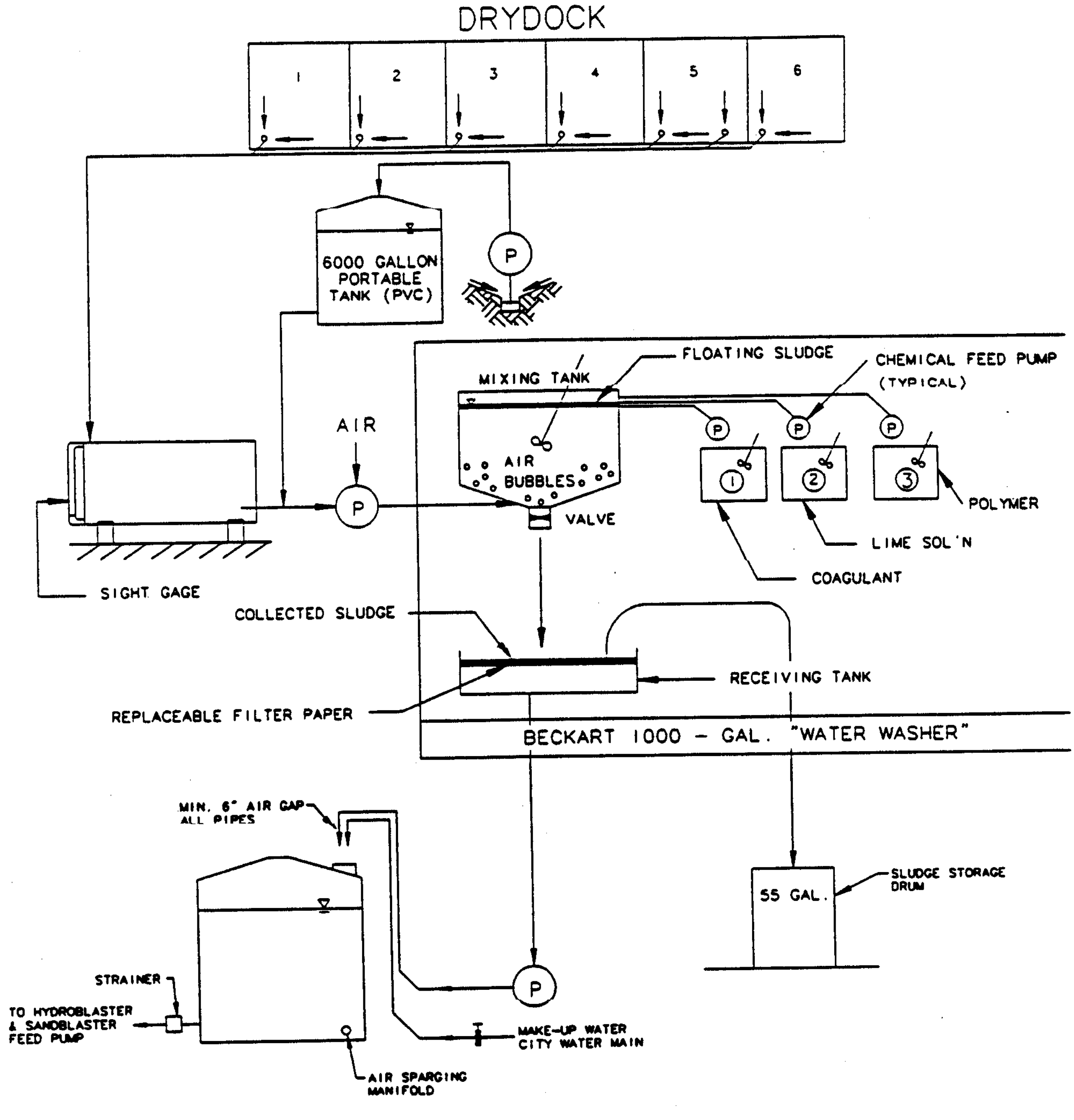
AK-WA, INC RECYCLING SYSTEM FLOW DIAGRAM



16,000 GALLON TREATED WATER STORAGE TANK (XLPE)

PART III

OPERATION AND MAINTENANCE

PART III A

OPERATION AND MAINTENANCE MANUAL
PER WAC 173-240-150

<u>OBJECTIVE:</u> To provide technical guidance and regulatory requirements to the operator to enhance operation under normal and emergency conditions.

2(a) <u>THE NAMES AND PHONE NUMBERS OF RESPONSIBLE INDIVIDUALS.</u>

Rocky Becker, Safety Director	272-0108	Office
	845-6178	Home
Dan Nichols, Superintendent	272-0108	Office
	565-8963	Home
Fred Olson, Manager	272-0108	Office
	851-3635	Home

Trained Operators:

Russel Corson
Don Beard
Rick Blanc
Dean Johnson

2(b) <u>PLANT TYPE, FLOW PATTERN, OPERATION, AND EFFICIENCY EXPECTED.</u>

Please reference the flow diagram on page 13.

The recycling process consists of nine steps:

1) Wastewater from the hydroblasting and sandblasting operations is collected in sumps in each of the six dry-dock units. A Wilden Model M-2 air-operated diaphragm pump removes wastewater from each sump and discharges it through a 3/4" hose to a 1-1/2" PVC pipe equipped with a ball valve and a swing check valve. Each of the six 1-1/2" pipes is connected to a 2" PVC wastewater header mounted on the drydock. The header on the drydock is connected to the wastewater holding tank on the pier.

2) The holding tank has a capacity of 3500 gallons: A sight glass is mounted on the tank to show how much capacity remains.

3) Wastewater is pumped from the holding tank to the treatment plant by the treatment unit's process pumps. The two pumps are each is rated at about 25 gallons per minute.

4) In the treatment plant, the upper tank of the unit is filled with 1,000 gallons of wastewater. The wastewater influent pump is shut off automatically by a floating switch when the proper level is reached. Backflow is prevented by a check valve in the influent line. It takes 15-20 minutes to fill the tank.

5) 1.5 gallons of Polyal-401 Aluminum Sulfate coagulant are added by a chemical feed pump operating on a pre-set timer. The coagulant is contained in a 55 gallon drum mounted on the treatment plant and is kept agitated by a mixer. Two mixers in the 1000 gallon tank disperse the coagulant. The coagulant is an acid and reduces the pH to about 4. During the mixing, the process pump is left on to circulate water and to add air bubbles. To increase the pH to the required 7, about 24 gallons of 5% hydrated lime solution (10 pounds dry weight) is added. The amount of lime solution is controlled by an automatic pH meter mounted on the tank, which shuts off the feed pump when the correct pH is reached. The pH may also be adjusted manually using pH paper.

6) After one minute of mixing, 4 gallons of B-40 polymer mixture is added by another chemical feed pump controlled by a pre-set timer. The polymer is stored in a 55 gallon drum mounted on the treatment plant. After an additional minute of mixing, the pump and mixer are turned off by a timer. Under quiescent conditions, the flocculated pollutants rise to the surface. This takes approximately 45 minutes. A sight gage on the side of the tank is used to verify that the floc has floated to the top. Additional polymer may be added by running the polymer pump manually if flotation is slow.

7) After flocculation and flotation, clean water is withdrawn from the mixing tank through a gravity drain at the bottom. The treated effluent then falls through a sheet of filter paper located in the underlying receiving tank. From the receiving tank, the treated effluent is pumped to the 16,000 clean water holding tank, where it is held for recycling.

8) The floating sludge follows the cleaned water out the valve in the bottom of the mixing tank, and collects on the filter paper below. The filtered sludge is then removed with a scoop shovel and placed in a 55 gallon drum. Each treatment batch adds about 8 inches of sludge to the barrel. When a drum is filled, it is mixed with spent sandblasting grit, then taken to Ideal Cement in Seattle for disposal. The sludge is not classified as a Dangerous Waste.

9) Clean water is pumped to a 16,000 gallon horizontal holding tank located at near the drydock.

10) To prevent the development of septic conditions in the treated water holding tank, an air sparging manifold will be placed in the bottom of the tank to periodically aerate the stored water. The sparging system will be fed by AK-WA's existing compressed air system. When conditions warrant (odor, algae formation, or turbidity) the sparging system will deliver a minimum air flow of 50 cfm for one hour.

2(c) THE PRINCIPAL DESIGN CRITERIA.

1) Total annual discharge (estimated) 120,000 gallons per year.

2) Batch treatment volume 1,000 gallons.

3) Raw wastewater contaminants are heavy metals (TR Copper up to 41,000 ug/l, TR Zinc up to 13,000 ug/l).

4) Operating hours, 8 hours/day (day shift).

5) No discharge (recycle only).

6) Average cycle time is 2 hours.

7) Maximum process water rate 12,000 gallons per day.

8) Average process water rate 4,000 gallons per day.

2(d) A PROCESS DESCRIPTION OF EACH PLANT UNIT, INCLUDING FUNCTION, RELATIONSHIP TO OTHER PLANT UNITS, AND SCHEMATIC DIAGRAMS.

Please refer to Item 2(b) above and to the Vicinity Map on page 1, the Flow Diagram on page 14, the holding tank details on page 15, the Drydock Dewatering System in Appendix D, and the Beckart Manual.

2(e) EXPLANATION OF THE OPERATIONAL OBJECTIVES FOR THE VARIOUS WASTEWATER PARAMETERS, I.E., SLUDGE AGE, SETTLEABILITY, ETC.

The plant operates through the process of coagulation, flocculation, and flotation. The Polyal 401 aluminum Sulfate coagulant reduces the net electrical repulsive forces at particle surfaces, allowing the particles to agglomerate. The coagulant is an acid and reduces the pH of the batch. The hydrated lime solution raises the pH back to neutral and assures that sufficient alkalinity is available for the coagulation reactions to occur. B-40 anionic flocculant is a polyelectrolyte coagulant aid and enhances the performance of the aluminum chloride coagulant.

The floc particles formed are slightly lighter than water. The addition of fine air bubbles through the process pumps helps the floc particles float to the surface.

Draining the mixing tank from the bottom assures that the replaceable filter paper in the lower tray is not blinded by sludge, because the sludge flows out only after the clean water does.

2(f) A DISCUSSION OF THE DETAILED OPERATION OF EACH UNIT AND A DESCRIPTION OF THE CONTROLS, SETTINGS, ETC.

Operation of the treatment plant is semi-automatic. The operator opens the inlet valve from the hydroblasting effluent holding tank to the treatment plant. In the treatment plant, the upper tank of the unit is filled with 1,000 gallons of wastewater. The wastewater influent pump is shut off automatically by a floating switch when the proper level is reached. Backflow is prevented by a check valve in the influent line.

1.5 gallons of Polyal-401 Aluminum Sulfate coagulant are added by a chemical feed pump operating on a pre-set timer. The coagulant is contained in a 55 gallon drum mounted on the treatment plant and is kept agitated by a mixer. Two mixers in the 1000 gallon tank disperse the coagulant. The coagulant is an acid and reduces the pH to about 4. During the mixing, the process pump is left on to circulate water and to add air bubbles. To increase the pH to the required 7, about 24 gallons of 5% hydrated lime solution (10 pounds dry weight) is added. The amount of lime solution is controlled by an automatic pH meter mounted on the tank, which shuts off the feed pump when the correct pH is reached.

After one minute of mixing, 4 gallons of B-40 polymer mixture is added by another chemical feed pump controlled by a pre-set timer. The polymer is stored in a 55 gallon drum mounted on the treatment plant. After an additional minute of mixing, the pump and mixer are turned off by a timer. Under quiescent conditions, the flocculated pollutants rise to the surface. This takes approximately 45 minutes. A sight gage on the side of the tank is used to verify that the floc has floated to the top. Additional polymer may be added manually if the flotation is slow.

After flocculation and flotation, clean water is withdrawn from the mixing tank through a gravity drain at the bottom. The treated effluent then falls through a sheet of filter paper located in the underlying receiving tank. From the receiving tank, the treated effluent is pumped to the 16,000 gallon clean water holding tank near the drydock to hold for recycling.

The floated sludge follows the cleaned water out the valve in the bottom of the mixing tank, and collects on the filter paper below. The filtered sludge is then removed with a scoop shovel and placed in a 55 gallon drum. When a drum is filled, it is mixed with spent sandblasting grit, then taken to Ideal Cement in Seattle for disposal. The sludge is not classified as a Dangerous Waste. The filter paper is changed after each batch.

A detailed set of instructions is included in the Manufacturer's Literature in Part IV B, also in Part V, Appendix 'C', and a copy is printed on the side of the treatment plant.

2(g) A DISCUSSION OF HOW THE FACILITIES ARE TO BE OPERATED DURING STARTUPS, SHUTDOWNS, AND MAINTENANCE PROCEDURES.

NOTE: Operation and maintenance of the pretreatment system shall be done only by one or more of the four hourly personnel listed in Section 2(a), Names and Phone Numbers of Responsible Individuals (page 17).

1) STARTUP PROCEDURE. This procedure shall be followed for each treatment run. A treatment run is composed of as many 1000 gallon treatment batches as it takes to empty the holding tank.

Prior to the start of each treatment run, the operator will check and verify the following items:

a) Pipe connections to raw wastewater holding tank, treatment plant, and clean water tank are made properly and do not leak.

b) Pipes are flagged to be plainly visible to equipment operators and foot traffic.

c) Inlet and outlet valves are operable.

d) Adequate chemical volumes are available in the three storage drums. Directions for mixing chemical solutions are included in the Beckart Operator's Manual, Part IV B. Minimum quantities are:

(1) 1.5 gallons of Polyal-401 solution per batch.

(2) 24 gallons of 5% hydrated lime solution for each batch. A new drum of lime solution will be required for each 1000 gallon treatment batch.

(3) 4 gallons of B-40 solution per batch.

e) Electric power, fresh water, and air supply connections are made.

f) All three chemical mixers are operating.

g) All three chemical feed pumps are operable.

h) Both tank mixers are operable.

i) Process pump is operable and primed.

j) Clean filter paper sheet in place and fastened down in bottom trays.

k) Empty barrel available for temporary sludge storage.

l) 16,000 gallon clean water storage tank has adequate capacity remaining for the water to be treated (1200 gallons minimum).

NOTE: Initial startup and calibrations are described in Beckart's Operator's Manual PART IV B. The plant was initially set up in August, 1992.

2) SHUTDOWN PROCEDURE. At the end of a treatment run, the operator will verify that:

a) Mixing tank walls are clean (sludge can be washed off with a garden hose and a broom).

b) Sludge is removed from bottom tray and placed in storage barrel.

c) All valves closed, including holding tank outlet valve.

d) Chemical feed pumps are flushed with clean water and drained.

e) Water-filled pumps are drained in freezing weather.

f) Electric power is shut off.

g) Chemical storage drums are covered.

h) Area is cleaned up and enclosure openings are fastened.

3) MAINTENANCE PROCEDURES (ALSO REFER TO SECTION 2i, MAINTENANCE SCHEDULE):

A responsible individual (Section 2a) will inspect and maintain the following items every 20 treatment runs or each month, whichever interval is shorter.

a) Dry-dock:

(1) Clean sumps, gravity drains, and sump pump inlet screens. Put material removed in sludge storage barrels.

(2) Make sure sump pumps are operable, in good condition, and lubricated.

(3) Make sure shutoff valves and check valves are operable.

(4) Make sure hoses and PVC headers are free of sediment (flush with clean water per maintenance schedule).

(5) Inspect all hoses and fittings. Replace any that are worn or damaged.

(6) Inspect all PVC piping for leaks, damage, or wear. Replace if necessary.

b) Raw Wastewater Holding Tank:

(1) Clean and flush sight glass with clean water.

(2) Flush petcock to remove sediment.

(3) Remove any sediment in bottom of tank and place in sludge storage barrels.

c) Beckart 1000 gallon treatment plant:

(1) Check calibration of pH meter (Instructions in Beckart Operator's Manual).

(2) Check condition of inlet and outlet pipes and fittings, replace if worn or broken.

(3) Check pump seals.

(4) Check hoses and fittings on chemical feed lines.

d) 16,000 gallon clean water holding tank:

(1) Check operation of level indicator (Shand & Jurs gauge).

(2) Check condition of inlet and outlet pipes and fittings, replace if worn or broken.

(3) Remove rainwater from secondary containment vessel (pump into clean water holding tank).

(4) Check water quality. Operate sparging system for one hour if water is turbid, has a noticeable odor, or has begun growing algae.

2(h) A SECTION ON LABORATORY PROCEDURES, INCLUDING SAMPLING TECHNIQUES, MONITORING REQUIREMENTS, AND SAMPLE ANALYSIS.

Samples will be taken from the clean water holding tank twice a year by the AK-WA, Inc. Safety Director and analyzed at AK-WA, Inc.'s expense. The water shall be analyzed for salinity and hardness.

The frequency of testing and the number and types of analytes may be modified in the future to reflect actual conditions, if agreed by the DOE. It may be necessary from time to time to replace the recycling water when sanity and hardness become objectionable. A permit from the City of Tacoma will be required before the water can be discharged to the sanitary sewer. The City will require a coy of the tests results before granting a permit. Provide a copy to:

City of Tacoma
Public Works Department Utility Services
Technical Support Division
2201 Portland Avenue
Tacoma, WA 98421-2711

2(i) BOOKKEEPING PROCEDURES AND SAMPLE FORMS TO BE USED:

Record keeping will consist of the following items:

1) Permanent files on all water quality testing.

2) All correspondence from Federal, State, and City agencies regarding sanitary sewer issues.

3) Copies of receipts from chemical manufacturers for coagulant, lime, and polymer.

4) Copies of receipts and correspondence with Ideal Cement (or other future sludge disposal facility). Records on the disposal of sludge must be maintained for at least three years.

5) Inspection reports.

6) Treatment Plant Operating Log.

7) Startup and Shutdown Checklist.

A copy of the Treatment Plant Operating Log is shown on the next page.

TREATMENT PLANT OPERATING LOG

OWNER: AK-WA, Inc.
401 Alexander, Bldg. 588
Tacoma, WA 98421

PLANT: Beckart 1000 gallon Water Washer

BATCH NO.	DATE	START TIME	FINISH TIME	GALLONS	OPERATOR'S INITIALS	NOTES

2(j) A MAINTENANCE SCHEDULE INCORPORATING MANUFACTURERS' RECOMMENDATIONS, PREVENTATIVE MAINTENANCE AND HOUSEKEEPING SCHEDULES.

A maintenance and inspection schedule is shown on the following page.

Since the plant operates on a batch mode, sometimes with several weeks between treatment runs, the inspection schedule is based on the start and finish of treatment runs. A treatment run may include as many as seven batches.

Regardless of the number of batches in a treatment run, the operator shall complete the following startup and shutdown checklist.

STARTUP AND SHUTDOWN CHECKLIST

OWNER: AK-WA, Inc.
401 Alexander, Bldg. 588
Tacoma, WA 98421

PLANT: Beckart 1000 gallon Water Washer

NOTE: This form must be completed for every treatment run, regardless of the number of batches in the run. A full explanation of each item listed below is shown in Section 2g of this report, pages 21 through 23.

DATE:____________________
NAME OF SHIP:____________________
AK-WA JOB NUMBER:____________________
NUMBER OF BATCHES:____________________

STARTUP CHECKLIST	YES	NO	COMMENTS
A) All pipes & fittings O.K.			
B) All valves O.K.			
C) Chemical storage sufficient.			
D) Power, water, & air.			
E) Mixers operable.			
F) Chemical feeders operable.			
G) Tank mixers operable.			
H) Pump and bubbler operable.			
I) Filter paper in place.			
J) Sludge storage O.K.			

SHUTDOWN CHECKLIST	YES	NO	COMMENTS
A) Mixing tank cleaned.			
B) Sludge stored in barrels.			
C) Valves closed.			
D) Chemical pumps cleaned.			
E) Water pumps drained.			
F) Power, water, & air off.			
G) Chemical drums covered.			
H) Area cleaned up.			

MAINTENANCE SCHEDULE

OWNER: AK-WA, Inc.
401 Alexander, Bldg. 588
Tacoma, WA 98421

PLANT: Beckart 1000 gallon Water Washer

NOTE: This form must be completed for every twenty (20) treatment runs or each month, whichever comes first. A full explanation of each item listed below is shown in Section 2g of this report, pages 21 through 23.

DRYDOCK MAINTENANCE	CHECKED
A) Sumps, drains, and screens clean.	
B) Sump pumps O.K.	
C) All valves operable.	
D) Hoses and headers clean.	
E) Pipes and fittings clean.	
WASTEWATER HOLDING TANK	**CHECKED**
A) Sight glass clean.	
B) Petcock clear.	
C) Sediment removed.	
TREATMENT PLANT	**CHECKED**
A) pH meter calibration.	
B) Inlet & outlet pipes O.K.	
C) Pump seals O.K.	
D) Chemical feed hoses O.K.	
CLEAN WATER HOLDING TANK	**CHECKED**
A) Level indicator O.K.	
B) Pipes, valves, and fittings O.K.	
C) Secondary containment intact & dry.	
D) Air Sparging system operable.	
______________________ **Inspector's Signature**	________ **Date**

Current Batch Number: ______________________

Batch Number at Previous Inspection: ______________

Comments:
____
____

PART III B, BECKART TREATMENT PLANT

OPERATOR'S MANUAL

WASTEWATER TREATMENT SYSTEM
OPERATORS MANUAL
FOR

AK-WA INC.
TACOMA, WA

BY

BECKART ENVIRONMENTAL, INC.
6900-46TH STREET
KENOSHA, WI 53144

PHONE (414) 656-7680
FAX (414) 656-7699

October 19, 1992

1000 GALLON SEMI-AUTO WATER WASHER
WASTEWATER TREATMENT SYSTEM BY:
BECKART ENVIRONMENTAL, INC.
6900 46TH STREET
KENOSHA, WI 53144
(414) 656-7680

TABLE OF CONTENTS

AK-WA INC.

TACOMA, WA

PROCESS FLOW DESCRIPTION:

System consists of two tanks, one superimposed on the other with a filter placed between. Micro-bubble addition pumps, mixers, and chemical metering pumps are operated from a control panel which has a monitoring pH meter in it.

Waste to be treated is put into the top tank, the mixers and pumps turned on. Necessary coagulants and buffer are pumped in to the water. After mixing for one minute, polymer is pumped in and allowed to mix for one more additional minute. The pump and mixer are shut off, and the flocked pollutants will rise to the surface. A bottom valve is then opened and the treated water allowed to run through the gravity filter. The floated sludge will follow and be caught on the filter paper. The filtered sludge is landfillable in many states as a dry waste. The cleaned water can be released from the bottom tank for recycling or sewering. If the water is not sufficiently clean for such use it can be returned to the top tank for retreatment.

Material Safety Data Sheet

Last revised Current as of 4/1/91

I. General Information

Chemical Name & Synonyms Polyal-201	Trade Name & Synonyms Metal salt
Chemical Family Acid	Formula $AlCl_3$
Proper DOT Shipping Name Aluminum Chloride Solution	DOT Hazard Classification Corrosive
Manufacturer Beckart Environmental Inc.	Manufacturer's Phone Number (414) 656-7680
Manufacturer's Address 6900-46th Street, Kenosha, WI 53144	Chemtrec Phone Number 1-800-424-9300

II. Ingredients

Principal Hazardous Components	Percent	Threshold Limit Value (units)
Aluminum Chloride CAS# 7446-70-0	25-36%	N/A
Hydrogen Chloride CAS# 7647-01-0	2.0%	N/A
Non-Hazardous Components		
Water CAS# 7732-18-5	75-64%	N/A

III. Physical Data

Boiling Point (°F) 250°F	Specific Gravity (H_2O = 1) 1.298-1.318
Vapor Pressure (mm Hg.) N/A	Percent Volatile By Volume (%) N/A
Vapor Density (Air = 1) N/A	Evaporation Rate (____ = 1) N/A
Solubility in Water Complete	pH 1.

Appearance & Odor
Odorless to chlorine - colorless to yellow-green

IV. Fire & Explosion Hazard Data

Flash Point (Test Method) Not flammable	Auto Ignition Temperature N/A	
Flammable Limits N/A	LEL	UEL

Extinguishing Media
N/A

Special Fire Fighting Procedures
None

Unusual Fire & Explosion Hazards
None

V. Health Hazard Data

Permissible Exposure Limit N/A	ACGIH Threshold Limit Value N/A
...inogen - NTP Program N/A	Carcinogen - IARC Program NO

...mptoms of Exposure
Pain, inflammation, difficulty breathing

...edical Conditions Aggravated By Exposure
N/A

...imary Route(s) of Entry
Inhalation, skin, ingestion

...ergency First Aid
Skin or eye contact - immediately flush with large amounts of water, remove to fresh air.

VI. Reactivity Data

...ability		Unstable	Conditions To Avoid: Avoid contact with basic materials.
	X	Stable	
...compatability			Materials To Avoid: Corrosive to metals. Avoid contact with basic compounds.
...azardous Polymerization		May Occur	Conditions To Avoid
	X	Will Not Occur	

...ardous Decomposition Products
Hydrogen chloride

VII. Environmental Protection Procedures

...Sp... Response
Neutralize small spills with 5% Na_2CO_3. Flush area with large amounts of water. Dike spill to prevent spread.

W...te Disposal Method
Dispose using appropriate neutralization techniques. Use approved hazardous waste treatment facility if and when necessary.

VIII. Special Protection Information

E... Protection: Chemical safety goggles	Skin Protection: Rubber gloves
Respiratory Protection (Specific Type): Acid vapor cannister	Ventilation Recommended: "Adequate" ventilation

C...er Protection
Rubber suit, eye wash, safety shower

IX. Special Precautions

Hygienic Practices In Handling & Storage
Corrosive material, use rubber gloves, suit, safety glasses, face shield as needed. Store in appropriate, corrosion proof tanks.

Precautions For Repair & Maintenance Of Contaminated Equipment
Wash thoroughly before repair and/or maintenance.

C...her Precautions
Wash thoroughly with soap and water after use.

BECKART ENVIRONMENTAL, INC.

6900 46TH STREET
KENOSHA, WI. 53144

PHONE # (414) 656-7680
FAX # (414) 656-7699

MATERIAL SAFETY DATA SHEETS (January 9, 1992)

I PRODUCT INFORMATION

PRODUCT NAME: BECKART B-40
NAME AND/OR FAMILY OR DESCRIPTION: ANIONIC FLOCCULANT
DOT HAZARD CLASSIFICATION: Non-Hazardous

CAS NUMBER: 25085-02-3, 64742-52-5, 64742-88-7
RCRA HAZARD CLASS: (If discarded) Non-Hazardous
EPA PRIORITY POLLUTANTS: None
SARA TITLE III (Sec. 313) Hazardous Material: None

II HAZARDOUS INGREDIENTS

This material contains no ingredients which are known by Beckart Environmental to be hazardous unless listed below.)

MATERIAL OR COMPONENT	TLV (UNITS)	APPROX. %
Rubber Solvent (NAPHTHA)	400 ppm	30-43

established by the American Conference of Governmental Industrial Hygienists and/or standards promulgated by the Occupational Safety and Health Administration.

III PHYSICAL DATA

BOILING POINT, °F :	>550
SOLUBILITY IN WATER @ 25°C :	Soluble - Solubility, Limited by Viscosity
SPECIFIC GRAVITY @ 25°C :	1.0 - 1.2
VAPOR PRESSURE, mm Hg @ 25°C:	<1
VAPOR DENSITY, (AIR=1) :	>1
APPEARANCE @ 25° C:	White Translucent Liquid
ODOR :	Organic
Flash Point, PMCC, °F :	>200

IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT: (See PHYSICAL DATA section)
FLAMMABLE LIMITS IN AIR, % BY VOLUME: Unknown
LOWER: Undetermined
UPPER: Undetermined
EXTINGUISHING MEDIA: Use Carbon Dioxide or Dry Chemical on small fires. Use foam (alcohol, polymer or ordinary) and water spray for large fires.
SPECIAL FIRE FIGHTING PROCEDURES: Self-Contained breathing apparatus and protective clothing should be worn in fighting fires involving chemicals.
UNUSUAL FIRE & EXPLOSION HAZARDS: None known to Beckart Environmental.

V HEALTH HAZARD DATA

.RESHOLD LIMIT VALUE: See HAZARDOUS INGREDIENTS section
FECTS OF OVEREXPOSURE: Contact with skin or eyes will cause irritation.-
E..ERGENCY AND FIRST AID PROCEDURES: Flush eyes with copious amounts of water fo: a minimum of 15 minutes. Wash contacted skin areas with soap and water. I: i ritation develops, consult a physician. Soaked clothing should be change(i mediately! With regard to inhalation, remove person to fresh air. I: artificial respiration is required, obtain medical help immediately.

VI REACTIVITY DATA

S ABILITY: STABLE: [X] UNSTABLE: [ ]
I..COMPATIBILITIES: (Materials to Avoid) Strong oxidizing material can cause reaction.
F ZARDOUS DECOMPOSITION PRODUCTS: Thermal decomposition or burning may produc c rbon mono/dioxides and/or nitrogen oxides.
HAZARDOUS POLYMERIZATION: May occur: [ ] Will not occur: [X]
CONDITIONS TO AVOID: See above statements

VII SPILL, LEAK AND DISPOSAL PROCEDURES

I :TION TO TAKE FOR SPILLS: (Use appropriate Safety Equipment) Use absorben material to collect and contain for disposal. Contain large spills and pump int(a suitable tank. Wash area with suitable detergent and thoroughly rinse.
' :SPOSAL METHOD: All local, state and federal regulations concerning health anc pollution should be reviewed to determine approved disposal procedures.

VIII SPECIAL HANDLING INFORMATION

VENTILATION:

) LOCAL EXHAUST: Sufficient exhaust ventilation to maintain exposure belov TLV.
-) MECHANICAL (general): Recommended.
) RESPIRATORY PROTECTION (type): Canister for organic/ammonia vapors (i.e. type GMD from Mine Safety Appliance Co.)

PROTECTIVE CLOTHING: Clean, body-covering clothing. In addition, rubber gloves, oots and apron, depending upon the exposure likely, or as required by youı company.
EYE PROTECTION: Chemical Workers Goggles recommended. Full face shielc ecommended when transferring material.
THER PROTECTIVE EQUIPMENT: Eye Fountain and Safety Shower in work area.

IX PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE

Store in well ventilated areas at temperatures below 120°F.

.his data is furnished gratuitously independent of any sales of the product and only for your investigation and independent verification. While the information is believed to be correct, Beckart Environmental, shall in no event : responsible for any damages whatsoever, directly or indirectly, resulting from the publication or use of or liance upon data contained herein. No warranty, either expressed or implied, of merchantability, of fitness, or of any nature with respect to the product, or to the data, is made herein. You are urged to obtain data sheets for -ll Beckart chemicals you buy, process, use, or distribute, and encouraged to advise anyone working with or exposed › such products of the information contained herein. State regulatory and Right-To-Know information is available upon request.

ıaterial Safety
)ata Sheet

ate ast revised AUGUST 30, 1990

I. General Information

nical Name & Synonyms
Calcium Hydroxide (Hydrated or Slaked Lime)

Chemical Family
A kaline Earth

Proper DOT Shipping Name

ufacturer
E ckart Environmental, Inc.

Manufacturer's Address
5?00-46th Street, Kenosha, WI 53144

Trade Name & Synonyms
C.P. (Chemically Pure) Hydrate

Formula
$Ca(OH)_2$

DOT Hazard Classification

Manufacturer's Phone Number
(414) 656-7680

Chemtrec Phone Number
1-800-424-9300

II. Ingredients

Principal Hazardous Components	Percent	Threshold Limit Value (units)
Pigments - N.A. (Not Applicable)	N.A.	N.A.
E se Metal - N.A.	N.A.	N.A.

III. Physical Data

Bo ng Point (°F)
?62°F

Vapor Pressure (mm Hg.)
N A.

Va or Density (Air = 1)
N.A.

So ubility in Water
N egligible

Appearance & Odor
White Powder - No Odor

Specific Gravity (H_2O = 1)
2.34

Percent Volatile By Volume (%)
25% Max @ 540°C

Evaporation Rate (______ = 1)
N.A.

pH

IV. Fire & Explosion Hazard Data

Flash Point (Test Method)
.A.

Fl mmable Limits
N.A.

Auto Ignition Temperature

LEL

UEL

E nguishing Media
.A.

Special Fire Fighting Procedures
Noncombustible - unlike quicklime, hydrated lime will not generate heat when in contact with water.

Unusual Fire & Explosion Hazards
one

V. Health Hazard Data

Sh Permissible Exposure Limit

ACGIH Threshold Limit Value
5 mg/M³, ACGIH - 1983

.nogen - NTP Program

Carcinogen - IARC Program

ır toms of Exposure
NHALATION: Moderate upper respiratory irritant.

.] AND SKIN: Caustic chemical burns.

eaical Conditions Aggravated By Exposure

.mary Route(s) of Entry
n'.alation, ingestion, skin contact

n. gency First Aid INHALATION: Remove person to fresh air. EYE AND SKIN: Flush immediately with ater - get medical attention. INGESTION: Give large quantities of water. Do not induce o iting - get medical attention.

VI. Reactivity Data

: ability	X	Unstable	Conditions To Avoid: Uncontrolled contact with acidic compounds
		Stable	
Incompatability			Materials To Avoid: Acidic compounds
Hazardous Polymerization		May Occur	Conditions To Avoid
	X	Will Not Occur	

:azardous Decomposition Products
None

VII. Environmental Protection Procedures

:p Response
Js normal clean-up procedures: sweep, shovel, or vacuum.

W. te Disposal Method
Dispose at any approved solid waste disposal site.

VIII. Special Protection Information

Ey Protection
W. ır goggles if possibility of eye contact

Respiratory Protection (Specific Type) Use NIOSH/MSHA approved dust and/or m st respirator if dust is generated

Skin Protection Wear clothing to fully protect skin from contact

Ventilation Recommended Local and/or general ventilation is recommended if threshold limit value is exceeded

O: er Protection
Wear protective work gloves to prevent skin contact.

IX. Special Precautions

Hygienic Practices In Handling & Storage
Keep product dry. Avoid excessive dust generation.

Precautions For Repair & Maintenance Of Contaminated Equipment
If there is any possibility of eye or skin contact, a supply of clean water should be ailable to flush affected area.

Other Precautions

POLYMER B40 MIXING PROCEDURE

1) For every 30 gallons of polymer that needs to be filled in the tank, measure out 16 ounces of liquid polymer B40 (or 1 quart of B40 per 60 gallons of water).

2) Turn on the fresh water line and fill the tank with water to at least the 2/3 level before pouring the *polymer into the polymer tank.

   *Be sure to add the water first before adding the polymer.

3) Fill the 30 gallon tank full before shutting off the water.

4) Turn on the polymer mixer and mix the polymer for 10 minutes.

5) Shut off the mixer as over mixing the polymer can actually sheer the B40 polymer making it less effective if the mixer is left operating for an extended period of time.

HYDRATED LIME MIXING PROCEDURES:

1) Mix lime in approximately 5% solution by weight. Therefore, for each 5 gallons of water, add two (2) pounds of lime to the tank.

2) To fill the hydrated lime tank, open the fresh water valve and close the valve at the bottom of the tank.

3) Fill lime tank half full of fresh water and then activate the lime tank mixer from the control panel.

4) Add the appropriate pounds of lime, which is determined by how large the tank is. Refer to step #1 (for example: 100 gallons of water would need 40 pounds of lime for a 5% solution).

5) Once the tank is full, shut off the fresh water valve and open the valve at the bottom of the tank.

6) Always turn lime mixer on for several minutes (10 minutes minimum) before adding to treatment tank.

OPTIONS:

A) To increase the concentration of the solution, add additional lime or caustic soda to the tank. Sodium hydroxide is the same as caustic soda.

B) To assist in the flotation of the floc, add one gallon of Surfact 88 to the lime/caustic tank.

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RELAY ADJUSTMENT PROCEDURE FOR ADDING CAUSTIC (RAISING THE pH)
OR SETTING ORP RANGES FOR CYANIDE DESTRUCT
GREAT LAKES INSTRUMENTS MODEL #671

1. Set "Control Relay Mode" switch to "Lo". This switch is on the back side of the front panel. (See figure 3-2 on page 20 of the Great Lakes manual).

2. Put "run/test" switch in test position.

3. If the meter is already calibrated, record that reading for later use to re-center the meter

4. [illegible] the "[illegible]/off/man" switch in [illegible] position.

5. Set the dead band "D.B." fully clockwise (20 complete turns to the right).

6. Turn the set point "ST.PT." adjustment fully counterclockwise (20 complete turns to the left).

7. Adjust the "test/offset" control to read the value at which you would like the pump to turn on.

8. Turn the set point control slowly clockwise until the yellow light just turns on.

9. Readjust the "test/offset" control to the point at which you would like the pump to turn off.

10. Turn the deadband control slowly counterclockwise until the yellow light just goes off.

11. The points at which the relay turns the pump on "set point" and running range to the off point or "deadband" can be checked by turning the "test/offset" control back and forth. While doing this observe where the yellow light turns on and off.

12. With the "test/offset" control return the meters reading to the reading that you recorded in step #3.

13. Return the "run/test" switch to the run position.

14. If the meter has not been calibrated, refer to page 1 of the Great Lakes manual for the procedure.

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CALIBRATION OF GREAT LAKES INSTRUMENTS pH METER
MODEL #671

1. Place run/test switch to run position.

2. Place clean sensor, with protective caps removed in pH 7 buffer, allow sensor to attain temperature equilibrium with the buffer (display reading stabilizes).

3. Adjust test/offset control until display indicated the value of the pH 7 buffer.

4. Remove sensor from the pH 7 buffer. Rinse sensor in tap or distilled water and place in second buffer (pH 4 or pH 10). Allow display reading to stabilize.

5. Adjust span control until display indicated the valve of the second pH buffer.

6. If proper reading cannot be displayed:

   A. Set span control to its mid-range position by turning it in one direction 20 complete turns. Then turn 10 complete turns in the opposite direction.

   B. Adjust coarse span control (figure 2-3) until display indicates correct reading.

7. Repeat above adjustment with the two different buffers until no difference occurs between the display reading and the known buffer valve.

8. The instrument is now calibrated.

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RELAY ADJUSTMENT PROCEDURE FOR LOWERING THE pH
OR SETTING UP ORP RANGES FOR CHROME DESTRUCT
GREAT LAKES INSTRUMENT MODEL #671

1. Set "Control Relay Mode" switch to "HI". This switch is on the back side of the front panel. (See figure 3-2 on page 20 of the G.L. manual).

2. Put "Run/test" switch in test position.

3. If the meter is already calibrated, record that reading for later use to re-center the meter. ____________________

4. Put the "Auto/off/man" switch in auto position.

5. Set the dead band "D.B." fuly clockwise (20 complete turns to the right).

6. Adjust the test/off set control to make the display indicate the value at which the relay is to turn on.

7. Turn the ST.PT. control slowly counterclockwise (left) until the uellow contorl indicator just lights (relay turns on).

8. Adjust test/offset contro to make display indicate the value at which the relay is to turn off.

9. Turn D.B. control slowly counterclockwice (left) until yellow control indicator just turns off (relay turns off).

10. The points at which the relay turns the pump on "set point" and running range to the off point or "Deadband" can be checked by turning the "test/offset" control back and forth. While doing this observe where the yellow light turns on and off.

11. With the "test/offset" control return the meters reading to the reading that you recorded in step #3.

12. Return the "run/test" switch to the run position.

13. If the meter has not be calibrated, refer to page 1 of the G.L. manual for the procedure.

RECOMMENDED CLEANING PROCEDURE FOR PROBES

Rinse the sensor with clean, warm water.

Prepare a mild soap solution. Use warm water and dishwashing detergent, Borax hand soap or other soaps that do not contain lanolin which will coat the glass process electrode.

Soak the sensor for 2 to 3 minutes in the soap solution.

Using a soft bristle brush, scrub the [illegible] of the sensor (glass electrode, salt bridge and [illegible]).

CAUTION: PERFORMANCE CAN BE DEGRADED BY SCRATCHING THE GLASS ELECTRODE. DO NOT USE A CLEANING BRUSH THAT CAN CAUSE SCRATCHES.

Before cleaning with acid, determine if any [illegible] products could form. For example, a sensor used in a [illegible] should not be put directly into a strong acid for cleaning [illegible] poisonous cyanide gas could be produced. Acids are hazardous and appropriate eye protection and clothing should be worn in accordance with Material Safety Data Sheet recommendations.

Soak the sensor for 4-5 minutes in muriatic acid. Rinse the sensor with clean, warm water and then place the sensor back into the mild soap solution. Soak it an additional 2 to 3 minutes to neutralize the acid.

Rinse the sensor in clean, warm water.

Calibrate the sensor and instrument with pH buffers (refer to instrument instruction manual). If calibration cannot be accomplished, replace the sensor's standard cell buffer and salt bridge (refer to sensor instruction manual).

Sensors which have an antimony (instead of glass) process electrode and that still cannot be calibrated after normal cleaning and replacement of the standard cell buffer and salt bridge may require addition electrode cleaning. The antimony electrode is brittle and can easily break. Use care when cleaning it. Very carefully file the tip of the antimony electrode and lightly scrape it rounded sides to remove and process coating.

WARNING: ANTIMONY IS TOXIC !! CAREFULLY DISPOSE ALL FILINGS. WHEN FINISHED, WASH HANDS THOROUGHLY.

SCHOTT

GREAT LAKES INSTRUMENTS

OPERATING INSTRUCTION MANUAL

Manual No. 178
Revision 7-1190

MODEL 671P (pH) AND 671R (ORP) ANALYZERS

Great Lakes Instruments, Inc.
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CONDENSED OPERATING INSTRUCTIONS

This manual contains detailed instructions for all operating aspects of the instrument. The following condensed instructions are provided to assist the operator in getting the instrument started up and running as quickly as possible. *These instructions are intended for when the instrument is used to measure pH.* They pertain to basic operation only. If specific instrument features are to be used, refer to the appropriate sections in the manual for complete details.

1. pH SENSOR HOOK-UP

After the instrument is properly mounted (Part Two, Section 2), connect the GLI Differential Technique pH sensor wires to DIFF. SENSOR Terminals on TB3, matching colors as indicated.

If the instrument is used with a pH combination electrode, connect it in accordance with the instructions detailed in Part Two, Section 3.1.

2. CALIBRATION

After the sensor is properly connected, the instrument must be calibrated so that measured values will accurately represent actual process values.

The following procedure requires a clean sensor and two fresh, accurate pH buffers (pH 7 and pH 4 or 10 buffers are recommended and are readily available).

NOTE: If a pH combination electrode is used, perform the procedure described in Part Three, Section 4.1 instead of the following procedure.

A. Place **RUN/TEST** switch to **RUN**.

B. Place clean sensor, with protective caps removed, in pH 7 buffer. Allow sensor to attain temperature equilibrium with the buffer (display reading stabilizes). Adjust **TEST/OFFSET** control until display indicates the value of the pH 7 buffer.

C. Remove sensor from the pH 7 buffer. Rinse sensor in tap (or distilled) water and place in second buffer (pH 4 or 10). Allow display reading to stabilize. Adjust **SPAN** control until display indicates the value of the second pH buffer. If proper reading cannot be displayed:

   a. Set **SPAN** control to its mid-range position by turning it in one direction 20 complete turns or until a "soft clicking" sound is heard. Then turn 10 complete turns in the opposite direction.

   b. Adjust **COARSE SPAN** control (Figure 3-2) until display indicates correct reading.

D. Repeat steps B and C until no difference occurs between the display reading and the known buffer value. The instrument is now calibrated.

3. RELAY SET-UP

To set-up the instrument's fully programmable relays for control or alarm purposes, refer to Part Three, Section 3.

TABLE OF CONTENTS

PART ONE - INTRODUCTION

PART TWO - INSTALLATION

PART THREE - OPERATION

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

PART ONE - INTRODUCTION

SECTION 1 - GENERAL INFORMATION

1.1 Instrument Capability

Measurement Versatility

This instrument can measure pH or ORP (mV) values and has a factory-set measuring scale. It may have a standard scale such as 0-14 pH, 0-1000 mV, etc. or a special scale. In either case, the instrument must be used with a GLI pH or ORP sensor that has an integral preamplifier (identified by its 5-wire cable) or a pH or ORP combination electrode. A pair of jumpers are used to program the instrument for either type of sensor input.

The instrument provides power for the sensor, receives the sensor's signals and processes those signals for indication, re-transmission and control or alarm purposes. If desired, the factory-set measuring scale may be field-changed.

Output Flexibility

Outputs include a 0-5 VDC/0-1 mA and 4-20 mA. When an optional plug-in isolator board is installed (Figure 3-2), it isolates the 4-20 mA output from ground, line power and the input signal. When an optional plug-in pulse module is installed instead of the isolator board, it provides a pulsed contact closure output in place of the 4-20 mA for variable-speed, pulse-driven pumps.

A proportional controller feature is provided for simple proportional only control applications (Part Three, Section 2.5). The 4-20 mA output is established over the range of interest to regulate a proportioning final control element.

The instrument has two fully programmable SPDT relays. Relays A and B can be independently configured with a setpoint, deadband and a low or high operating mode. The low mode of operation energizes the relay in response to a decreasing measured value; the high mode in response to an increasing measured value. An **AUTO/OFF/MAN** switch provides added control flexibility for Relay A. Also, Relay B may be operated as a dual-alarm relay; it will energize when the measured value decreases below a selected low alarm point or increases above a selected high alarm point. LED's above the instrument display light up to indicate that the relays are energized.

Operator Safety

Modular construction simplifies field servicing and provides electrical safety for the operator. The display module assembly

(Figure 3-1) contains voltages no greater than 24 VDC and is completely safe to handle. The display module assembly is removable to access the terminal strips on the power-supply board. The relays and optional plug-in isolator or pulse output module (if supplied) are located on the back side of the power-supply board.

WARNING: REMOVE LINE POWER BEFORE HANDLING POWER-SUPPLY BOARD TO AVOID ELECTRICAL SHOCK.

1.2 Product Identification

The serial # of your instrument is located below the controls on the display module assembly (Figure 3-1). The matrix below lists all of the instrument options. Use it as a handy reference when re-ordering. Write the serial # in the space provided below the matrix for convenient identification when technical assistance is required.

MODEL NUMBER
671 Analyzer in NEMA 4X, 1/2 DIN, PVC enclosure with SS mounting brackets

TYPE OF MEASUREMENT
P1 for pH
R1 for ORP (mV)

ANALOG OUTPUT (Non-isolated 0-1 mA/0-5 VDC plus:)
C Non-isolated 4-20 mA
F Isolated 4-20 mA
P Pulsed, contact closure (specify maximum pulses/minute; 80 to 120)

LINE VOLTAGE
1 115 volts, 50/60 Hz.
2 230 volts, 50/60 Hz.

RELAYS
G Two control relays; each with independently selectable operating mode and adjustable setpoint and deadband. Also, Relay B has high alarm point feature for dual-alarm operation.

RESERVED CATEGORIES

671				G	0	N	--- **Product Number**

Serial #____________________

SECTION 2 - SPECIFICATIONS

2.1 Operational

Display .... Analog meter with 3-1/2" mirrored scale

Measuring Range:

pH .... 0-14 pH

ORP .... (-)1000 to (+)1000 millivolts

Ambient Conditions .... -30 to 50°C (-22 to 122°F), 0 to 100% relative humidity, non-condensing

Relay Function:

Setpoints.................... Adjustable from 0-100% of measuring scale

Deadbands .... Adjustable from 0-15% of measuring scale

Indicators .... LED lights when respective relay energizes

Outputs .... Two SPDT contact outputs, U.L. rating: 5A 115/250 VAC, 5A @ 30 VDC resistive

NOTE: *Relays energize in response to increasing or decreasing reading, switching selectable. When a low mode of operation is selected for Relay B, it may be operated as a dual-alarm relay. A high alarm setpoint may be applied so that Relay B will also energize in response to an increasing reading. In this mode, the high alarm setpoint has a fixed deadband of 2% of the measuring scale span.*

Temperature Compensation .... Automatic, 0-100°C (32-212°F) or fixed with resistor value

Sensor-to-Analyzer Distance .... 3000 feet maximum for GLI 5-Wire Differential Technique sensor

-or-

10 feet maximum for direct connection of combination electrode (a GLI Model 714 preamp is required for distances greater than 10 feet)

Power Requirements..... 98-132 VAC, 50/60 Hz (less than 5VA), optional 195-265 VAC, 50/60 Hz

Analog Outputs:

Standard .... Non-expandable and non-isolated*:
0-1 mA, 100 ohms maximum load
-or-
0-5 VDC, 500K ohms minimum load

Expandable and non-isolated*:
4-20 mA, 825 ohms maximum load

Optional .... Isolation* for expandable 4-20 mA output only, 575 ohms maximum load

*Non-isolated outputs are isolated from ground and line power, but not from the input or each other. The isolated output is isolated from the input, ground, line power and all other outputs.

Range Expand - The 4-20 mA analog output can be made to represent a selected segment of the measuring scale. This segment or "sub-interval span* cannot be smaller than 10% of the measuring scale span, but may be positioned anywhere within that span.

Controller Outputs:

Current........................One signal (uses analog output): 4-20 mA, 900 ohms maximum load

NOTE: *If 4-20 mA is isolated, maximum load is limited to 575 ohms.*

Pulsed........................One dry contact closure, 0 to user-specified maximum of 80-120 pulses/minute (set to 100 unless specified otherwise), 50 millisecond contact closure, pulse frequency is proportional to 0-100% of the controller output. Contact rating is 200 VDC, 1/2 amp. DC, 10 watts maximum.

2.2 Analyzer Performance (Electrical, Analog Outputs)

Sensitivity........................0.1% of span

Stability........................0.1% of span per 24 hrs., non-cumulative

Non-Linearity........................0.05% of span

Repeatability........................0.1% of span

Temperature Drift..........Zero: 0.01% of span per °C
Span: 0.015% of span per °C

Response Time.............3 seconds to 90% of value upon step change

2.3 Mechanical

Enclosure........................NEMA 4x, 1/2 DIN, PVC with two 1/2-inch conduit holes and two stainless steel mounting brackets

Mounting Configurations...............Surface, panel and horizontal pipe mount. Vertical pipe mounting optional.

Net Weight........................3 lbs. (1.36 kg)

PART TWO - INSTALLATION

SECTION 1 - UNPACKING

After unpacking, save the shipping carton(s) and packing materials for possible future storage or for re-shipment. Inspect the equipment and packing materials for signs of shipping damage. If there is an indication of damage, file a claim with the carrier immediately.

SECTION 2 - MECHANICAL REQUIREMENTS

2.1 Location

1. Locate the instrument within 3000 feet of where the GLI 5-wire Differential Technique sensor is to be installed. If a combination electrode is used, the Model 671 must be located within 10 feet of the electrode for a direct cable run. A GLI Model 714 preamp may be used to extend this distance to 3000 feet, but the preamp must be located within 10 feet of the electrode.
2. Mount in as clean and dry a location as possible where minimal mechanical vibration exists. Avoid locations where corrosive fluids may fall on the instrument or where ambient temperature limits (-30 to 50°C, -22 to 122°F) may be exceeded.

2.2 Mounting

Refer to Figure 2-1 for enclosure and mounting dimension details. Figure 2-2 illustrates various mounting configurations. Use the two stainless steel brackets provided to panel, surface

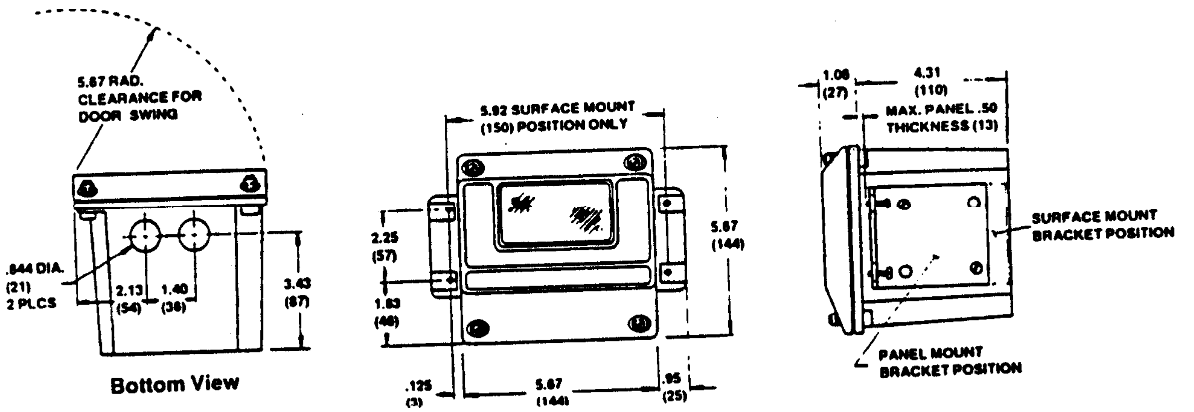


FIGURE 2-1 Enclosure Outline

or pipe-mount the instrument. The bracket attachment configuration determines the mounting method.

To panel mount the instrument:

1. Place Tinnerman fasteners on each mounting bracket as shown in Figure 2-2.

2. Place instrument into square panel cutout (5.43 x 5.43", 138 x 138 mm) and fasten brackets to instrument case with No. 8-32 x 3/8" long screws.

   NOTE: *Use appropriate mounting bracket holes (depicted in Figure 2-2 with screw heads) to properly position brackets.*

3. Fasten No. 10-32 x 3/4" long screws into Tinnerman fasteners until ends of screws are snugged against panel.

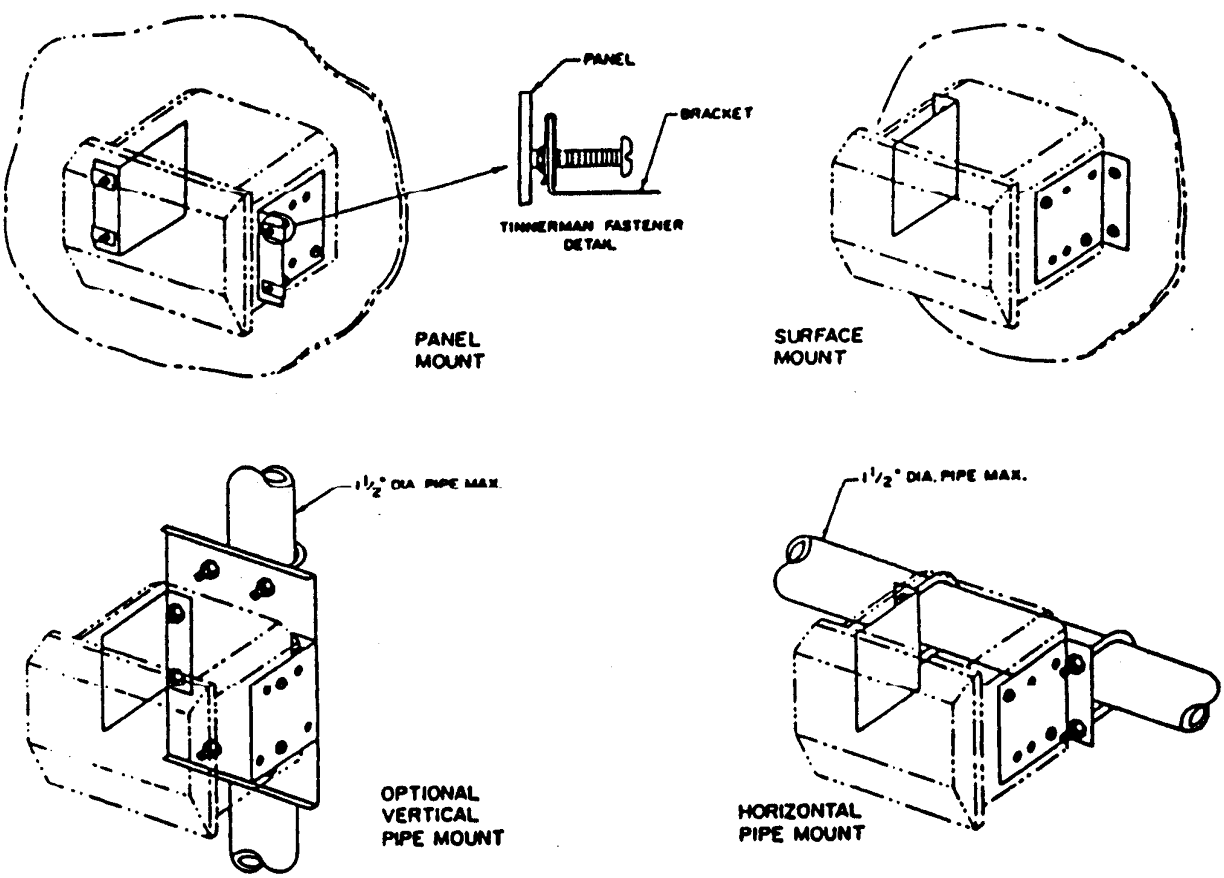


FIGURE 2-2 Mounting Configurations

2.3 Plugging Conduit Holes

Conduit hubs or cable feed-thru fittings should be used where cables enter the enclosure. Holes not used for cable entry should be sealed with plugs.

NOTE: *Use NEMA 4 rated fittings and plugs to maintain the watertight integrity of the NEMA 4 enclosure. Generally, the left conduit hole (viewed from front) is used for power and relay wires; the right conduit hole for sensor input and instrument output wires.*

SECTION 3 - ELECTRICAL CONNECTIONS

To access terminal strips for electrical connections, loosen four thumbscrews and open enclosure door. Carefully remove display module assembly by loosening the two captive fasteners (Figure 3-1 on page 19). If necessary, the ribbon-cable connector may be disconnected from the power-supply board. Figure 3-2 on page 20 shows terminal designations for instrument hook-up.

3.1 Sensor

It is recommended that sensor signal wires be run in 1/2" metal conduit for protection against moisture and mechanical damage. Do not run signal wires in same conduit with power or control wiring ("electrical noise" may interfere with sensor signal).

When Using GLI 5-Wire Differential Technique Sensor

Connect sensor (or interconnect cable) wires to DIFF. SENSOR terminals on TB3, matching colors as indicated. It is highly recommended to connect the sensor to the instrument indirectly with a junction box and interconnect cable. This wiring method makes electrical connections more convenient whenever the sensor is replaced or requires maintenance.

When Using Combination Electrode

1. Direct Hook-up (For Distances of 10 Feet Or Less)

   A. Connect active electrode (center wire in coaxial cable) to ACTIVE terminal post.

   B. Connect reference electrode (shield wire) to SHLD (REF.) terminal on TB3.

   C. Temperature Compensation Wiring

      a. Automatic With Internal Temperature Sensor

         Connect temperature compensation wires (red and black for GLI industrial combination sensors) to TEMP terminals on TB3, disregarding wire color designations.

b. Automatic With External Temperature Sensor

Connect external temperature sensor wires (GLI p/n 60A2A9860-series) across TEMP terminals on TB3, disregarding wire color designations.

c. Fixed With External Resistor

Connect a resistor (its specific value must correspond with desired temperature) across TEMP terminals on TB3, disregarding wire color designations. The following table provides specific resistor values require for the listed fixed temperature compensation.

Table A - FIXED TEMPERATURE COMPENSATION RESISTOR VALUES

°C	Resistor Value (in ohms	°C	Resistor Value (in ohms)
0	771	55	114
5	631	60	99
10	519	65	85
15	430	70	74
20	358	75	65
25	300	80	57
30	252	85	50
35	213	90	44
40	181	95	39
45	155	100	35
50	133		

2. Indirect Hook-up With Model 714 Preamp (For Distances Greater Than 10 Feet)

The GLI Model 714 preamp must be located within 10 feet of the combination electrode. The Model 671 can be located up to 3000 feet from the preamp. Refer to the Model 714 preamp instruction manual for electrical connection details between the combination electrode, the preamp and Model 671.

3.2 Analog Outputs

0-1 mA/0-5 VDC

This dual-purpose output represents the measuring scale. Th 0-5 VDC output requires a minimum load of 500,000 ohms (fo ±1% accuracy). The 0-1 mA output can drive a load of up t 100 ohms. Connect load (-) to OUTPUT LO terminal and loa (+) to OUTPUT 0-5V/0-1 mA terminal on TB3.

4-20 mA

The 4-20 mA output can represent either the measuring scale or a selected segment of it (Part Three, Section 2.4). To avoid measurement errors caused by ground loops, the 4-20 mA output can be isolated when an optional plug-in isolator board is installed (Part Four, Section 3.1). However, when the 4-20 mA output is isolated, it is limited to driving a load of no greater than 575 ohms. When not isolated, the 4-20 mA output can drive a load of up to 825 ohms. Connect load to 4-20 mA OUTPUT terminals on TB1, matching polarity as indicated.

3.3 Pulsed Output (Optional)

An optional pulsed contact closure output can be provided at the 4-20 mA OUTPUT terminals on TB1 in place of the designated 4-20 mA output when a plug-in pulse module is installed (Part Four, Section 3.2). The maximum pulses per minute (80 to 120) is factory-set to a user-specified value. Each output pulse lasts 50 milliseconds. The pulsed output is intended to be used with the proportional controller feature (Part Three, Section 2.5) for variable-speed pulse-driven pumps and is proportional to 0-100% of the controller output.

3.4 Relay Outputs

Two sets of SPDT relay outputs are provided at terminals on TB2. Those designated "CONTROL" are for Relay A; "ALARM" for Relay B. They are not powered. However, the instrument's line power may be used to power control or alarm devices via these relay contacts. Refer to Figure 2-3 for wiring details. Two unfused power terminals designated L1 on TB2 are provided to connect line power to the relay outputs. Always check control wiring to insure that line power will not be shorted by the switching action of the relay contacts. Refer to Part Three, Section 3 for relay set-up instructions.

NOTE: *Because of space limitations within the instrument*

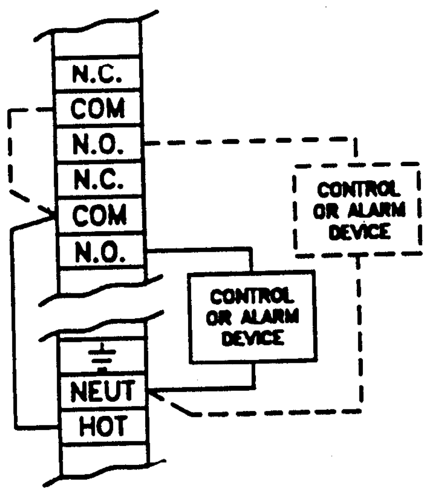


FIGURE 2-3 Connecting Control Or Alarm Device(s) To Relay Outputs

enclosure, it is recommended that bulky wiring connections (resulting from combinations of multiple connections per terminal and large gauge wires) be terminated outside the instrument enclosure, preferably in an external junction box.

CAUTION: Do not exceed each relay's contact rating of 5A 115/230 VAC. If larger currents are to be switched, use of an auxiliary relay will extend relay life. When relay outputs are used, the instrument's line power wiring must be adequate to conduct the anticipated load(s).

3.5 Line Power

Connect line power to MAINS terminals on TB2 which are not fused. Use wiring practices which conform to local codes (National Electrical Code Handbook in the U.S.A.). Use only the standard three-wire connection. The ground terminal grounds the instrument which is mandatory for safe operation.

CAUTION: Any other wiring method may be unsafe or cause improper operation of the instrument.

It is recommended not to run line power or relay outputs powered off the line in the same conduit with input signal wires ("electrical noise" may interfere with input signal).

PART THREE - OPERATION

SECTION 1 - OPERATING CONTROLS

Frequently used controls are located on front of the display board (Figure 3-1). They are accessed by opening the enclosure door which can be easily removed by unsnapping it from its hinge. Seldom used controls are located on the back-side of the display module assembly (Figure 3-1) and on the front of the power-supply board (Figure 3-2). To access seldom used controls, remove module assembly from instrument case by loosening two captive fasteners.

WARNING: DO NOT ADJUST THE FACTORY-SEALED (RED SEALANT) POTENTIOMETERS. IF SEALS ARE BROKEN, THE INSTRUMENT WARRANTY IS VOIDED. IF THE INSTRUMENT IS RETURNED TO GLI AND ANY OF THE FACTORY-SEALED POTENTIOMETERS RE-QUIRES RE-ADJUSTMENT, A FACTORY SET-UP CHARGE WILL BE INCURRED.

All switches, controls and program jumpers used for instrument operation are described in this section. Familiarize yourself with each item before operating the instrument.

NOTE: *All controls are "twenty-turn" potentiometers which do not have mechanical stops at their adjustment endpoints. To adjust these controls to an endpoint, slowly turn adjustment screw in one direction 20 complete turns or until a "soft clicking" sound is heard.*

1.1 pH/ORP Measurement Select

1. **pH/ORP** jumper (Figure 3-2)

   Selects pH or ORP measurement. Jumper must be in place for measuring pH. Remove jumper to measure ORP.

1.2 GLI 5-Wire Sensor/ Combination Electrode Select

2. **INPUT SELECT** jumpers (Figure 3-2)

   This jumper pair programs the instrument to be used with a GLI 5-Wire Differential Technique sensor or a combination electrode. Both jumpers must be in the same respective position.

   COMB - Use this position when a combination electrode is directly connected (electrode must be within 10 feet of instrument).

DIFF - Use this position when a GLI 5-wire Differential Technique sensor is used or when a combination electrode is indirectly connected with a GLI Model 714 preamp (electrode is greater than 10 feet from instrument).

1.3 Calibration

3. **METER ZERO** screw (located on meter face)

   Adjusts meter movement mechanically to align meter pointer to minimum-scale value with line power removed from the instrument.

4. **RUN/TEST** switch (Figure 3-1)

   RUN - Connects sensor signal to instrument scaling circuits to measure process value.

   TEST - Connects internally generated signal to scaling circuits for test or diagnostic purposes. In this position, process values can be simulated with **TEST/OFFSET** control to manually set display reading and analog outputs to any desired value. Relay setpoints and range expand are established with **RUN/TEST** switch in **TEST** position.

5. **TEST/OFFSET** control (Figure 3-1)

   This control has two functions depending on the position of the **RUN/TEST** switch:

   A. In **RUN**, it compensates for offset error of the sensor signal by adjusting display reading to proper value for calibration.

   B. In **TEST**, it shifts display reading and analog outputs for test or diagnostic purposes, relay set-up and range expand.

6. **SPAN** control (Figure 3-1) and
   COARSE SPAN control (Figure 3-2)

   Compensates for span error of the sensor signal by adjusting display reading to proper value for calibration with **RUN/TEST** switch in **RUN**.

1.4 Range Expand/ Proportional Controller Set-up

7. **CONTROL ACTION** jumper (Figure 3-2)

   ■ For Range Expand:

   Selects 4-20 mA output to be direct (**DIR.**) or inverted (**REV.**).

   DIR. - 4-20 mA output increases as measured value increases.

REV. - 4-20 mA output increases as measured value decreases.

■ For Proportional Controller:

Selects direction of control action.

DIR. - Controller output increases as measured value increases above the controller setpoint.

REV. - Controller output increases as measured value decreases below the controller setpoint.

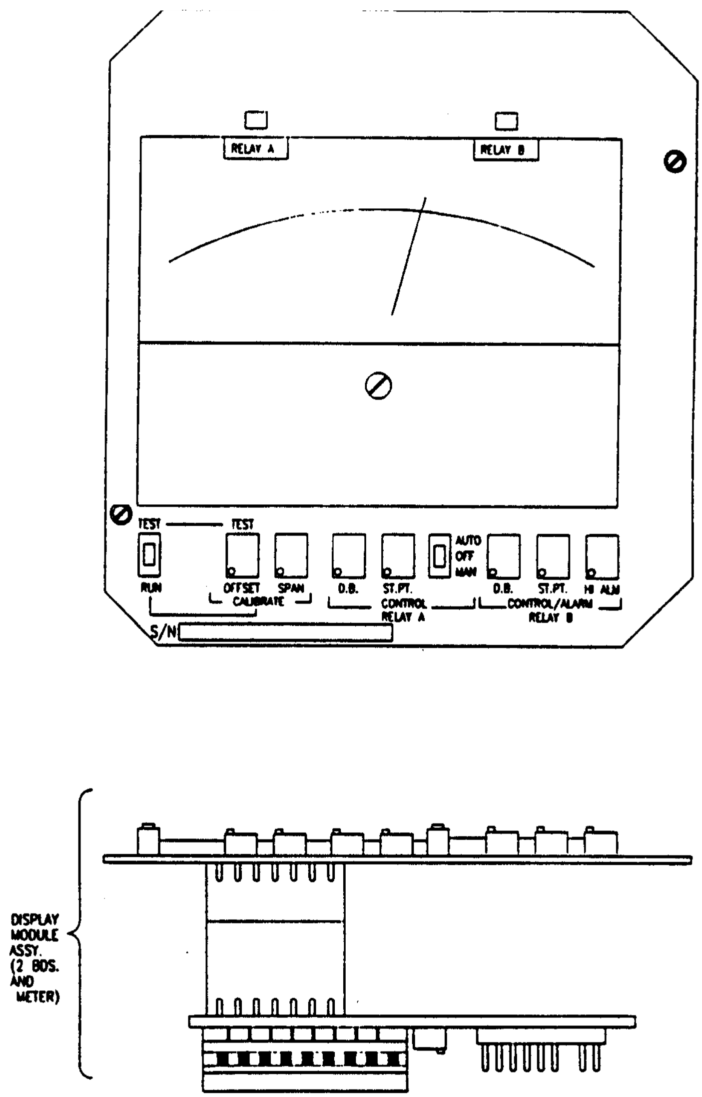


FIGURE 3-1 Display Module Assembly —Controls On Frontside Of Display Board

8. **INT.SHIFT/ST.PT.** control (Figure 3-2)

   - For Range Expand:

     Adjusts 4-20 mA output to 4 mA to correspond with low endpoint of measuring scale or selected segment of it. The segment's low endpoint may be established anywhere within the measuring scale.

   - For Proportional Controller:

     Establishes the setpoint at which the controller output is 0% (4 mA or zero pulses per minute when optional pulse module is installed).

9. **INT. SPAN/GAIN** control (Figure 3-2)

   - For Range Expand:

     Adjusts 4-20 mA output to 20 mA to correspond with high endpoint of measuring scale or selected segment of it. The segment's high endpoint must be greater than the segment's low endpoint by at least 10% of the measuring scale span.

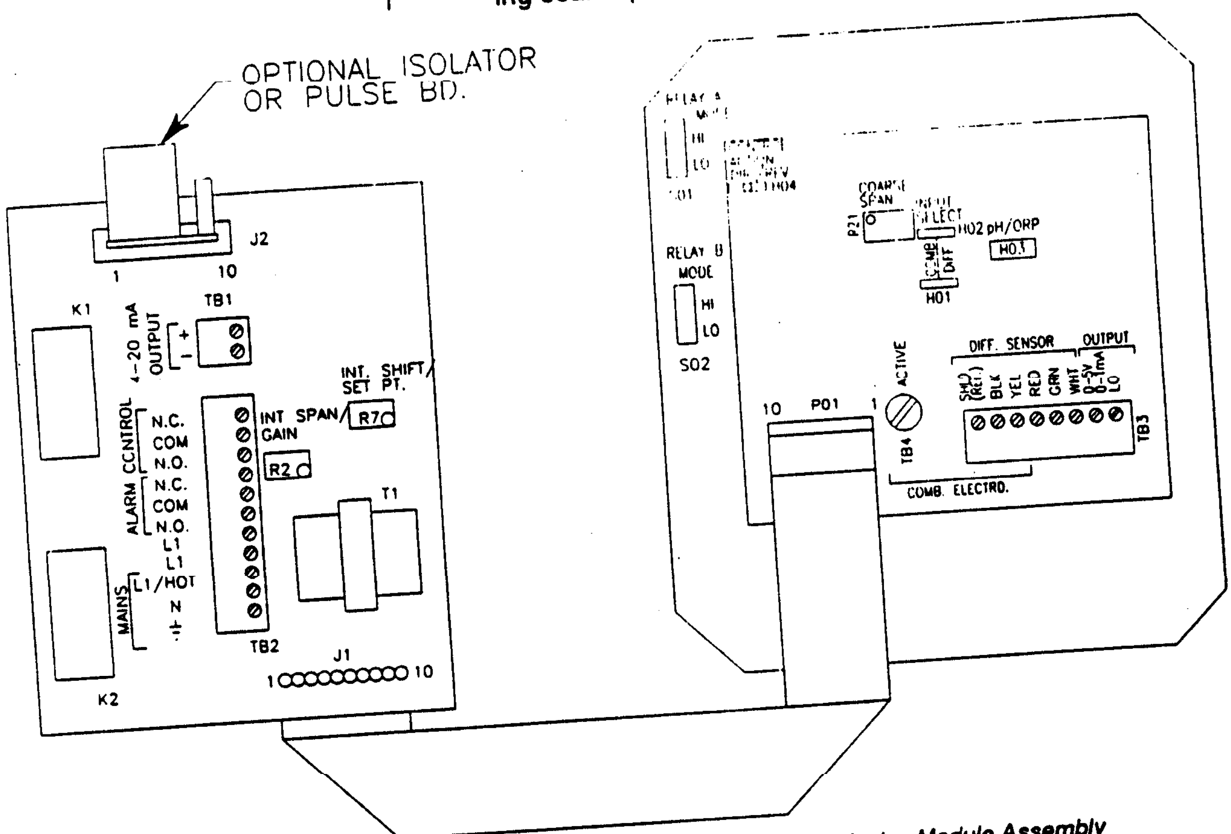


FIGURE 3-2 *Controls On Power-Supply Board, Backside of Display Module Assembly And Electrical Hook-up Details*

- For Proportional Controller:

  Establishes the controller gain at which the controller output is 100% (20 mA or maximum user-specified number of pulses per minute when optional pulse module is installed).

1.5 Relay Set-up

10. **RELAY A MODE** and **RELAY B MODE** switches (Figure 3-2)

    HI - Selects high mode of operation for respective relay; relay energizes in response to increasing process value.

    LO - Selects low mode of operation for respective relay; relay energizes in response to decreasing process value.

11. **ST.PT. A** and **ST.PT. B** controls (Figure 3-1)

    Sets the point at which the respective relay (A, B) turns on in response to <u>increasing</u> process value. The relay remains on whenever the process value is <u>above</u> this selected setpoint value. Adjustment range is 0-100% of measuring scale.

    NOTE: *Underlines indicate high mode of relay operation. Opposite relay operation occurs when low mode is selected with **RELAY MODE** switches (item 10).*

12. **D.B.A** and **D.B.B** controls (Figure 3-1)

    Sets the point at which the respective relay (A, B) turns off when the process value <u>decreases below</u> the preselected setpoint value (set with **ST.PT.** controls). This establishes a range (deadband) in which the relay remains on. Adjustment range is approximately 0-15% of the measuring scale span.

    NOTE: *Underline indicates high mode of relay operation. Opposite relay operation occurs when a low mode is selected with **RELAY MODE** switches (item 10).*

13. **RELAY A** and **RELAY B** indicators (yellow, Figure 3-1)

    Respective indicator lights whenever instrument's control state turns on the relay.

14. **AUTO/OFF/MAN** switch (Figure 3-1)

    AUTO - Relay A is automatically operated by the instrument as required.

    OFF - Relay A is off continuously, regardless of instrument's control state.

MAN - Relay A is on continuously, regardless of instrument's control state.

15. **HI ALM.** control (Figure 3-1)

Sets the point at which Relay B turns on in response to increasing process value when low mode of operation is selected with **RELAY B MODE** switch. See Part Three, Section 3.3 for complete details on the high alarm point feature.

SECTION 2 - INSTRUMENT START-UP

2.1 Initial Control Settings

1. Before operating the instrument for the first time, place the following controls and switches to these settings:

Control	Setting
RUN/TEST switch	**TEST**
TEST/OFFSET control	Mid-range*
SPAN control	Mid-range*
D.B.A and **D.B.B** controls	Fully counterclockwise (left)
ST.PT.A and **ST.PT.B** controls	Fully clockwise (right)
AUTO/OFF/MAN switch	**AUTO**
HI ALM. control	Fully clockwise (right)
RELAY A MODE and **RELAY B MODE** switches	**HI**
COARSE SPAN control	Leave at factory setting
CONTROL ACTION jumper	**DIR.**
INT. SHIFT/SET PT. control	‡
INT. SPAN/GAIN control	‡

*To set these controls to mid-range, turn in one direction 20 complete turns or until a "soft clicking" sound is heard. Then turn 10 complete turns in the opposite direction.

‡Leave at factory setting unless range expand or proportional controller feature is used. Refer to Part Three, Section 2.4 or 2.5 for details.

2. Apply line power and allow the instrument to stabilize for at least 10 minutes before performing initial calibration. While waiting, select the pH/ORP measurement mode of operation and program the instrument for the type of sensor input that will be used. If the range expand or proportional controller feature is to be used, it can also be set.

2.2 Selecting pH/ORP Measurement Mode

The instrument is factory-set to measure either pH or ORP. To measure pH, a jumper (H3 located on backside of display module assembly, Figure 3-2) must be installed across circuit board holes designated as **"pH/ORP"**. To measure ORP (millivolts), this jumper must be cut or removed.

2.3 Programming For Type Of Sensor Input

The instrument must be programmed to accept the type of sensor input which will be used. For a combination electrode that is to be directly connected to the instrument (within 10 ft.), place **INPUT SELECT** jumpers (H1 and H2 on backside of display module assembly, Figure 3-2) to **COMB** position. For a GLI 5-wire Differential Technique sensor or a combination electrode that is to be connected by way of a GLI Model 714 preamp, place jumpers to **DIFF** position.

NOTE: *Both jumpers must be in same position.*

2.4 Using Range Expand Feature

The 4-20 mA output on TB1 can represent the measuring scale or a desired segment of it. The **INT. SHIFT/SET PT.** and **INT. SPAN/GAIN** controls (Figure 3-2) are used to make this output correspond with low and high endpoints of the measuring scale or segment. A milliammeter is required to monitor the 4-20 mA output value.

NOTE: *The selected segment cannot be smaller than 10% of the measuring scale span, but may be positioned anywhere within that span.*

For Direct Output

The procedure to use the range expand feature is described with the following example:

> RANGE EXPAND SET-UP EXAMPLE
>
> Suppose the measuring scale is 0-14 pH. In this case, the smallest segment that may be expanded is 1.4 pH units (10% of measuring scale span). Suppose the 4-20 mA output is desired between 5 and 10 pH and it's to increase as the process value increases (direct output).

1. Connect milliammeter in series *with load* to appropriate output terminals, observing polarity as indicated.

2. Place **RUN/TEST** switch to **TEST**. Turn **INT. SHIFT/SET PT.** control fully clockwise (20 complete turns to the right) and **INT. SPAN/GAIN** control fully counterclockwise (20 complete turns to the left).

   NOTE: *If instrument is calibrated, note value shown on display when placing **RUN/TEST** switch to **TEST**.*

*After setting the range expand feature, use **TEST/OFFSET** control to restore noted reading so calibration will be maintained when **RUN/TEST** switch is returned to **RUN**.*

3. Place **CONTROL ACTION** jumper (Figure 3-2) in **DIR.** position.

4. Adjust **TEST/OFFSET** control to make Model 671 indicate the value at which 4 mA is to be provided (5 pH for this example). Adjust **INT.SHIFT/SET PT.** control until milliammeter reads 4.00 mA.

5. Adjust **TEST/OFFSET** control to make Model 671 indicate the value at which 20 mA is to be provided (10 pH for this example). Adjust **INT.SPAN/GAIN** control until milliammeter reads 20.00 mA.

6. Repeat steps 4 and 5 until low and high endpoints of the segment correspond exactly with the 4 mA and 20 mA output values respectively. For this example, the 4-20 mA output now increases between 5 and 10 pH.

CAUTION: The 4-20 mA output can exceed its designated values when the measured value is not within the selected segment. Should this occur, the output is limited to 40 mA.

For Inverted Output

For applications that require the output to decrease as the process value increases (an inverted output):

1. Perform steps 1 through 6 listed in "For Direct Output" in this section.

2. Place **CONTROL ACTION** jumper in **REV.** position.

3. Adjust **TEST/OFFSET** control to make Model 671 indicate the value at which 20 mA is to be provided (5 pH for this inverted output example). Adjust **INT.SHIFT/ SET PT.** control counterclockwise (left) until milliammeter reads 20.00 mA. The output is now inverted.

2.5 Using Proportional Controller Feature

The proportional controller feature is intended to be used for simple proportional only control applications. The **INT.SHIFT/SET PT.** and **INT.SPAN/GAIN** controls are used to make the 4-20 mA output correspond with the desired controller operating range. A **CONTROL ACTION** jumper (Figure 3-2) is provided to select the direction of control action that the controller will pursue. A milliammeter is required to monitor the 4-20 mA output.

NOTE: *The selected range in which the controller will operate cannot be smaller than 10% of the measuring scale span, but may be positioned anywhere within that span.*

For Direct Output

The procedure to use the proportional controller feature is described with the following example:

> PROPORTIONAL CONTROLLER SET-UP EXAMPLE
>
> Suppose the measuring scale is 0-14 pH. In this case, the smallest range in which the controller will operate is 1.4 pH units (10% of measuring scale span). Suppose the controller output is to increase as the process value increases (direct output). When the process value is 6 pH (setpoint), the output is to be 0% (4 mA or zero pulses/minute if optional pulsed output is used). When the process value is 9 pH (gain), the output is to be 100% (20 mA or maximum pulses/minute if optional pulsed output is used).

1. If the 4-20 mA output is used, connect milliammeter *in series* with load to OUTPUT Terminals on TB1. If optional pulsed output is used, remove the pulse output board (Figure 3-2) and insert jumper board (supplied with instrument) in its place. This allows the 4-20 mA output that drives the pulse board to be monitored.

2. Place **RUN/TEST** switch to **TEST**. Turn **INT.SHIFT/ SET PT.** control fully clockwise (20 complete turns to the right) and **INT.SPAN/GAIN** control fully counterclockwise (20 complete turns to the left).

   NOTE: *If instrument is calibrated, note value shown on display when placing **RUN/TEST** switch to **TEST**. After setting the proportional controller feature, use **TEST/OFFSET** control to restore noted reading so calibration will be maintained when **RUN/TEST** switch is returned to **RUN**.*

3. Place **CONTROL ACTION** jumper (Figure 3-2) in **DIR.** position. For pH applications, this position is used for acid feed and **REV.** position for caustic feed.

4. Adjust **TEST/OFFSET** control to make Model 671 indicate the value at which the minimum output is to be provided (6 pH for this example). Adjust **INT. SHIFT/SET PT.** control until milliammeter reads 4.00 mA.

5. Adjust **TEST/OFFSET** control to make Model 671 indicate the value at which the maximum output is to be provided (9 pH for this example). Adjust **INT.SPAN/GAIN** control until milliammeter reads 20.00 mA.

6. Repeat steps 4 and 5 until low and high endpoints of the control range correspond exactly with the minimum and maximum output values respectively. For this example, the controller output now increases between 6 and 9 pH.

7. If optional pulsed output is used, remove jumper board and insert pulse board in its place (Figure 3-2).

CAUTION: The 4-20 mA output can exceed 20 mA when the measured value is not within the selected control range. Should this occur, the output current may not continue to correctly track the measured value and is limited to 40 mA. However, if the optional plug-in pulse module is installed, the maximum number of pulses per minute is limited to the user-specified number within 5%.

For Inverted Output

For applications that require the controller output to decrease as the process value increases (an inverted output):

1. Perform steps 1 through 6 listed in "For Direct Output" in this section.

2. Place **CONTROL ACTION** jumper in **REV.** position.

3. Adjust **TEST/OFFSET** control to make Model 671 indicate the value at which the maximum output is to be provided (6 pH for this inverted output example). Adjust **INT. SHIFT/SET PT**. control counterclockwise (left) until milliammeter reads 20.00 mA. The output is now inverted.

4. If optional pulsed output is used, remove jumper board and insert pulse board in its place (Figure 3-2).

2.6 Initial Calibration

Upon start-up, calibrate the instrument using the procedure described in Part Three, Section 4.1 for pH or Section 4.2 for ORP.

SECTION 3 - RELAY SET-UP

Relay A and Relay B each have an adjustable setpoint and deadband and a selectable operating mode. When the low mode of operation is selected, the relay will turn on when the process value decreases below the setpoint. In the high mode, the relay will turn on when the process value increases above the setpoint. Relay B has an additional **HI ALM.** control which can be used when its low mode of operation is selected. This provides Relay B with two setpoints for use as a dual-alarm relay (see Section 3.3 for details). An **AUTO/OFF/MAN** switch provides added control flexibility for Relay A. LED's on the control panel light to indicate that the relay is energized.

The procedure to set up the relays is described with the following example:

RELAY SET-UP EXAMPLE
Suppose the measuring scale is 0-14 pH and operational requirements for Relay A are: Relay A turns on at 10 pH as the pH increases. Relay A turns off at 9 pH as the pH decreases below the setpoint value.

3.1 Selecting Relay Operating Modes

Locate **RELAY A MODE** and **RELAY B MODE** switches (Figure 3-2) and place respective switches in appropriate positions. For this example, set **RELAY A MODE** switch in the **HI** position. For applications that require the relay to turn on in response to decreasing process value, place this switch in the **LO** position and turn respective **ST.PT.** control fully counterclockwise (20 complete turns to the left).

NOTE: *When a high mode of operation is selected for Relay B, turn the **HI ALM.** control fully clockwise (right) so that its effect does not interfere with the **ST.PT.B** control when setting the Relay B setpoint.*

3.2 Setting Relay Setpoints and Deadbands

1. Place **RUN/TEST** switch to **TEST**, **AUTO/OFF/MAN** switch to **AUTO** and turn respective **D.B.** (deadband) control fully counterclockwise (20 complete turns to the left).

   NOTE: *If instrument is calibrated, note value shown on display when placing **RUN/TEST** switch to **TEST**. After establishing relay setpoints, use **TEST/OFFSET** control to restore noted reading so calibration will be maintained when **RUN/TEST** switch is returned to **RUN**.*

2. To set a relay setpoint, adjust **TEST/OFFSET** control to make display indicate the value at which the relay is to turn on (10 pH for Relay A in this example). Turn respective **ST.PT.** control *slowly* counterclockwise (clockwise when relay is set for low mode of operation) until yellow **RELAY** indicator just lights (relay turns on).

3. To set a relay deadband (with relay on), turn respective **D.B.** control fully clockwise (20 complete turns to the right). Adjust **TEST/OFFSET** control to make display indicate the value at which the relay is to turn off (9 pH for Relay A in this example). Turn respective **D.B.** control *slowly* counterclockwise (left) until yellow **RELAY** indicator just turns off (relay turns off).

NOTE: *When changing a relay setpoint, always turn respective **D.B.** control fully counterclockwise (20 complete turns to the left) before performing steps 2 and 3.*

4. To verify that relays turn on and off at their adjusted setpoints, use the **TEST/OFFSET** control to *slowly* shift the display reading back and forth through the full measuring scale. If further adjustment is required, repeat the steps previously described.

5. Place **RUN/TEST** switch to **RUN** for "measuring" mode.

3.3 Using Relay B High Alarm Point Feature

When the low mode of operation is selected for Relay B, it turns on in response to decreasing process value. By using the **HI ALM.** control, Relay B will also turn on when the process value increases above this high alarm point value. Consequently, the high alarm point feature allows Relay B to be used as a dual-alarm relay for audible and/or visual alarm purposes. The high alarm point has a fixed deadband of 2% of the measuring scale span while the low alarm point, set with the **ST.PT.B** control, has an adjustable deadband of 0-15% of the measuring scale span. Figure 3-3 illustrates the dual-alarm operation of Relay B.

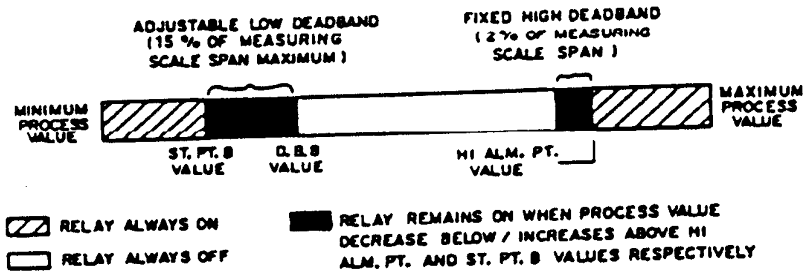


FIGURE 3-3 Dual-Alarm Operation of Relay B

NOTE: *When a high mode of operation is selected for Relay B, do not use the high alarm point feature. Make sure the **HI ALM.** control is fully clockwise (20 complete turns to the right) so that its effect does not interfere with the **ST.PT.B** control when setting the Relay B setpoint.*

SECTION 4 - CALIBRATION

The instrument must be calibrated periodically with reference solution(s) to maintain measurement accuracy. It is highly recommended to establish a maintenance program to keep the sensor clean and the instrument calibrated. The time period between performing maintenance (days, weeks, etc.) is affected by the characteristics of the process solution and can only be determined by operating experience. For example, a sensor operating in waste water that contains oil and/or grease may require more frequent cleaning.

4.1 For pH Measurement

This procedure requires a clean sensor and two fresh, accurate pH buffers (pH 7 and pH 4 or 10 buffers are recommended and are readily available).

1. Place **RUN/TEST** switch to **RUN.**
2. Place *clean* sensor, with protective caps removed, in pH 7 buffer. Allow sensor to attain temperature equilibrium with the buffer (display reading stabilizes). Adjust **TEST/OFFSET** control until display indicates the value of the pH 7 buffer.

   NOTE: *If a pH combination electrode is used with an external temperature sensor, place the temperature sensor in pH buffer along with the electrode during this step and step 3. If a pH combination electrode is used with a fixed temperature compensation resistor (Table A on page 14), bring temperature of the pH buffer used in this step and step 3 to the specific temperature that corresponds with the listed resistor value.*

3. Remove sensor from the pH 7 buffer. Rinse sensor in tap (or distilled) water and placed in second buffer (pH 4 or 10). Allow display reading to stabilize. Adjust **SPAN** control until display indicates the value of the second pH buffer. If proper reading cannot be displayed, set this control to its mid-range position by turning it counterclockwise (left) 20 complete turns and then 10 complete turns to the right. Now adjust **COARSE SPAN** control on backside of display module assembly (Figure 3-2) until display indicates correct reading.
4. Repeat steps 2 and 3 until no difference occurs between the display reading and the known buffer value. The instrument is now calibrated.

4.2 For ORP (mV) Measurement

One of three methods can be used to calibrate the instrument. With each method, use the **TEST/OFFSET** control only. The **SPAN** and **COARSE SPAN** controls are factory-set and sealed to provide the proper output span for the GLI ORP sensor. If a different ORP measuring scale is required or the Model 671 is eventually used to measure pH, the seals may be broken so that the controls can be readjusted.

Zeroing Method

This method can only be used when the ORP measuring scale is zero-based or includes zero millivolts within the scale. (Example: 0-1000 mV, -500 to +500 mV, etc.)

1. Place **RUN/TEST** switch to **TEST**. The sensor need not be connected.
2. Adjust **TEST/OFFSET** control until display indicates "zero millivolts". The instrument is now calibrated.
3. Place **RUN/TEST** switch to **RUN** for "measuring" mode.

ORP Reference Solution Method

This procedure requires a fresh, accurate ORP reference solution with a millivolt value that is within the measuring scale of the instrument. If an ORP reference solution is not available, the "transfer" method may be used.

1. Place **RUN/TEST** switch to **RUN**.
2. Place *clean* sensor, with protective caps removed, in a fresh ORP reference solution (available from GLI) with a millivolt value that is within the measuring scale. Allow sensor to attain temperature equilibrium with the solution (display reading stabilizes).
3. Adjust **TEST/OFFSET** control until display indicates the value of the ORP reference solution. The instrument is now calibrated. If proper reading cannot be attained within 50 to 60 millivolts of the known ORP reference solution value, the sensor should be replaced. Consult manufacturer for sensor warranty and return policy.

Transfer Method

This procedure requires a calibrated laboratory or portable ORP instrument and a sample of process solution.

1. Place **RUN/TEST** switch to **RUN**.
2. Obtain a stable sample of the process solution. Place *clean* sensor in this sample to allow it to attain temperature equilibrium.
3. Measure the sample's ORP value with a calibrated laboratory or portable ORP instrument.
4. Adjust **TEST/OFFSET** control until Model 671 indicates the value measured with the laboratory or portable ORP instrument. The Model 671 is now calibrated.

PART FOUR - OPERATING AIDS

SECTION 1 - PRESERVING MEASUREMENT ACCURACY

1.1 Keeping Sensor Clean

Clean the sensor as required using the recommended procedure described in the sensor operating instruction manual.

1.2 Keeping Instrument Calibrated

Calibrate the instrument as experience dictates, using the procedure described in Part Three, Section 4. Errors in readings may be caused by using a diluted or contaminated pH buffer solution when calibrating the instrument. For best accuracy, do not reuse buffers. The system can never be more accurate than the buffers used to calibrate it. Note that buffer solutions may change in value with ambient temperature. Therefore, the sensor and buffer solution should be allowed to come to the same temperature and the value of the buffer at that temperature, should be known.

1.3 Avoiding Ground Loop Errors

The instrument may be affected by a "ground loop" electrical problem which can cause any of the following symptoms to occur:

1. Instrument reading will be offset from actual process value by a consistent amount (up to 30% of full scale).
2. Instrument reading will not change even though actual process value is changing.
3. Instrument reading will peg offscale (up or down).

When the sensor is placed in a buffer solution to check the instrument, it typically displays a correct reading because the container that is used is normally plastic or glass which prevents the solution from being grounded. To test for a ground loop, place **RUN/TEST** switch to **RUN** and put sensor in a solution of known value. Observe the reading. Then place an earth grounded wire in the same solution with the sensor and observe the reading again. If the reading changes, a ground loop is present.

A ground loop may occur when an instrument output is used to drive an external device which has a grounded input (recorder, computer, etc.). To correct this problem, the instrument output must be isolated. Another possible cause of a ground loop is when there is moisture in a junction box which provides a conductive pathway from the sensor connections to earth ground. In this case, keep terminal connections dry and prevent them from getting corroded.

1.4 Avoiding Electrical Interferences

Do not run sensor wires in the same conduit with line power. Excess wire should not be coiled near motors or other equipment that may generate electric or magnetic fields. Cut wires to proper length during installation to avoid unnecessary inductive pick-up ("electrical noise" may interfere with sensor signal).

SECTION 2 - CHANGING THE MEASURING SCALE

2.1 For pH Measurement

The new pH measuring scale cannot have a span of less than 5 pH units or more than 14 pH units. The low endpoint of the measuring scale must be between 0 and 7 pH inclusive. The procedure to set the measuring scale requires a digital voltmeter, a new or marked-up meter scale and two fresh, accurate pH buffers (pH 7 and pH 4 or 10 buffers are recommended and are readily available).

1. Connect voltmeter to 0-5/0-1 mA and LO terminals on TB3 to monitor the 0-5 VDC output.
2. With sensor wires appropriately connected to designated terminals on TB3, verify that **INPUT SELECT** jumpers are in the correct position for the type of sensor input used. Refer to Part Three, Section 2.3 for details.
3. Wire jumper (H3) should be installed across circuit board holes designated **"pH/ORP"** which are located on backside of display module assembly (Figure 3-2).
4. Place **RUN/TEST** switch to **RUN** and turn **SPAN** control fully counterclockwise (20 complete turns to the left). Then turn **SPAN** control 10 complete turns to the right to its mid-range setting.
5. When sensor is placed in one of the pH buffers, the instrument provides a corresponding voltage output value. Instruments with different measuring scales provide different voltage output values for the same pH buffer. Calculate the voltage output values for the buffers used in this procedure with the following formula:

$$\boxed{\text{Voltage} = 5 \times [(\text{Buffer Value} - \text{Scale Minimum}) \div (\text{Scale Maximum} - \text{Scale Minimum})]}$$

For example, suppose the measuring scale is to be 4-14 pH and pH 7 and pH 10 buffers are to be used:

For pH 7 buffer, Voltage = 5 x [(7 - 4) ÷ (14 - 4)]
or 1.5 volts

For pH 10 buffer, Voltage = 5 x [(10 - 4) ÷(14 - 4)]
or 3.0 volts

6. Place clean sensor, with protective caps removed, in pH 7 buffer. Allow sensor to attain temperature equilibrium with the buffer (display reading stabilizes). Adjust **TEST/OFFSET** control until voltmeter indicates the correct voltage value for pH 7 buffer calculated with the formula in step 5.
7. Remove sensor from the pH 7 buffer. Rinse sensor in tap (or distilled) water and place in second buffer (pH 4 or 10). Allow display reading to stabilize. Adjust **COARSE SPAN** control (Figure 3-2) until voltmeter indicates the approximate voltage value for the second buffer (pH 4 or 10) calculated with the formula in step 5.
8. Adjust **SPAN** control until voltmeter indicates the exact voltage value for the second buffer (pH 4 or 10) calculated with the formula in step 5.
9. Repeat steps 6, 7 and 8 until no difference occurs between displayed voltage reading and calculated voltage.
10. Mark new measuring scale on existing scale or install new scale.
11. Disconnect voltmeter. If a segment of the measuring scale is to be represented by the 4-20 mA output, adjust the **INT.SHIFT/ST.PT.** and **INT.SPAN/GAIN** controls at this time using the range expand procedure described in Part Three, Section 2.4.

2.2 For ORP (mV) Measurement

The new mV measuring scale cannot have a span of less than 250 mV or more than 2000 mV. The low endpoint of the measuring scale must be between 0 and (-)1000 mV inclusive. The procedure to set the measuring scale requires a digital voltmeter, a new or marked-up meter scale and two fresh, accurate ORP reference solutions whose values are within the measuring scale span. To avoid excessive control adjustment interaction when setting the new measuring scale, it is recommended that ORP reference solution values be at least 100 millivolts apart.

1. Connect voltmeter to 0-5V/0-1 mA and LO terminals on TB3 to monitor the 0-5 VDC output.
2. With sensor wires appropriately connected to designated terminals on TB3, verify that **INPUT SELECT** jumpers are

in the correct position for the type of sensor input used. Refer to Part Three, Section 2.3 for details.

3. Wire jumper (H3) should be cut or removed from circuit board holes designated "pH/ORP" which are located on backside of display module assembly (Figure 3-2).

4. Place **RUN/TEST** switch to **RUN** and turn **SPAN** control fully counterclockwise (20 complete turns to the left). Then turn **SPAN** control 10 complete turns to the right to its mid-range setting.

5. When sensor is placed in one of the ORP reference solutions, the instrument provides a corresponding voltage output value. Instruments with different measuring scales provide different voltage output values for the same ORP reference solution. Calculate the voltage output values for the ORP reference solutions used in this procedure with the following formula:

Voltage=5 x [(Reference Solution Value - Scale Minimum) ÷ (Scale Maximum - Scale Minimum)]

   For example, suppose the measuring scale is to be 0-1000 mV and 200 mV and 600 mV ORP reference solutions are to be used:

   For 200 mV solution, Voltage = 5 x [(200 - 0) ÷ (1000 - 0)] or 1.0 volts

   For 600 mV solution, Voltage = 5 x [(600 - 0) ÷ (1000 - 0)] or 3.0 volts

6. Place clean sensor, with protective caps removed, in lower value ORP reference solution. Allow sensor to attain temperature equilibrium with the solution (display reading stabilizes). Adjust **TEST/OFFSET** control until voltmeter indicates the correct voltage value for lower ORP reference solution calculated with the formula in step 5.

7. Remove sensor from the lower value ORP reference solution. Rinse sensor in tap (or distilled) water and place in higher value solution. Allow display reading to stabilize. Adjust **COARSE SPAN** control (Figure 3-2) until voltmeter indicates the approximate voltage value for the higher ORP reference solution calculated with the formula in step 5.

8. Adjust **SPAN** control until voltmeter indicates the exact voltage value for the higher value ORP reference solution calculated with the formula in step 5.

9. Repeat steps 6, 7 and 8 until no difference occurs between the displayed voltage reading and the calculated voltage value.

10. Mark new measuring scale on existing scale or install new scale.

11. Disconnect voltmeter. If a segment of the measuring scale is to be represented by the 4-20 mA output, adjust the **INT.SHIFT/ST.PT.** and **INT.SPAN/GAIN** controls at this time using the range expand procedure described in Part Three, Section 2.4.

SECTION 3 - OPTIONAL PLUG-IN MODULES

3.1 Isolator Board (For 4-20 mA Output Only)

The optional plug-in isolator board isolates the 4-20 mA output on TB1 from all other outputs, the input signal and line power. If optional plug-in pulse module is installed, the isolator board cannot be used.

NOTE: *If the Model 671 is factory-equipped with a plug-in isolator board, disregard the installation and adjustment procedures in this section.*

Installation

1. *Disconnect line power.* Remove display module assembly by loosening two captive fasteners and disconnecting ribbon-cable connector located to the left of TB4.

2. Refer to Figure 3-2 and locate the J2 edge connector (shown with optional isolator or pulse board plugged in). Unplug small jumper board from edge connector. Save this board for future use should non-isolated output again be required.

3. Orient optional module as shown in Figure 3-2 and plug it into edge connector. Make sure it is fully inserted.

   NOTE: *If module is plugged in backwards, the output at TB1 will not be provided. No damage to the module or instrument will occur.*

4. Install display module assembly with captive fasteners.

Adjusting Isolated 4-20 mA Output

The isolated 4-20 mA output must now be adjusted to compensate for isolator effects. Use the procedure described in Part Three, Section 2.4 to make the isolated 4-20 mA output correspond with the low and high endpoints of the measuring scale or a desired segment of it.

3.2 Pulse Output Module

The optional plug-in pulse output module provides a pulsed contact closure output at terminals on TB1 in place of the 4-20 mA output normally provided. This pulsed output is intended to be used with the proportional controller feature (see Part Three, Section 2.5) for variable-speed pulse-driven pumps. The 0-100% controller output provides between zero and the maximum user-specified number of pulses/minute (80-120) respectively. If optional plug-in isolator board is installed, the pulse module cannot be used.

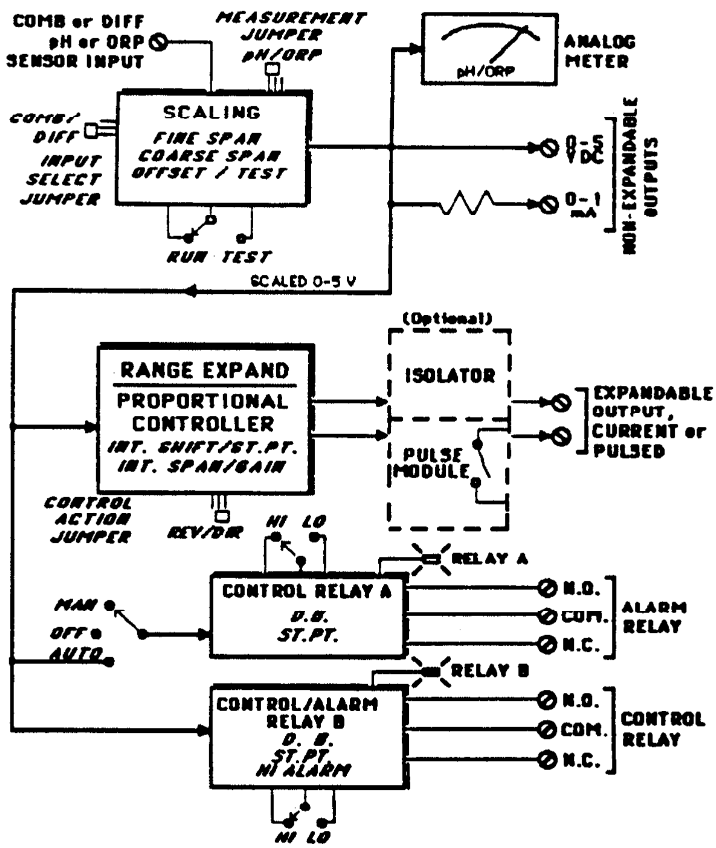
NOTE: *If the Model 671 is not factory-equipped with a plug-in pulse module, install the module using the procedure described in 3.1 of this section.*

PART FIVE - PRINCIPLE OF OPERATION

See Figure 5-1 for functional diagram pertaining to these descriptions:

1. The power-supply section (not shown) converts line power to appropriate voltages for circuit operation.

2. In the **RUN** mode, the scaling section converts the sensor input signal to a 0-5 VDC signal. The 0-5 VDC signal is offset and spanned over desired measuring scale to obtain a "scaled" 0-5 VDC signal. In the **TEST** mode, a test signal is substituted for the sensor input signal. The scaled 0-5 VDC signal represents the process value (**RUN** mode) or test value (**TEST** mode) and is used for display indication, outputs (relay, current and voltage), and range expand or proportional control. The scaled 0-5 VDC signal is present at terminals on TB3. For low impedance loads, the 0-5 VDC output functions as a 0-1 mA output.



Controls and Jumpers are listed in *ITALICS*.

FIGURE 5-1 Instrument Operations Block Diagram

3. The relay control sections (2) compare the scaled 0-5 VDC signal to a setpoint voltage. The relay is turned on or off based on measured process value, deadband and selected high/low operating mode (control relay only). When a relay is turned on, the respective relay LED lights to indicate that the relay is energized.

4. The range expand/proportional controller section operates in two ways:

   A. For range expand use, it shifts and spans the scaled 0-5 VDC signal to correspond with the minimum and maximum values respectively of the measuring scale or selected segment of it. This 0-5 VDC signal is converted to a 4-20 mA signal which is present at terminals on TB1.

   B. For proportional controller use, it proportions the scaled 0-5 VDC signal to correspond with the user-adjusted setpoint and gain values respectively.

5. The optional plug-in isolator, if provided, isolates only the expandable 4-20 mA output signal from ground, line power and the instrument input.

6. The optional plug-in pulse output module, if provided, uses the expandable 4-20 mA controller output signal to produce a pulsed contact closure at terminals on TB1. The user-specified pulse frequency range is proportional to 0-100% of the controller output.

PART SIX - SERVICE AND MAINTENANCE

SECTION 1 - GENERAL

1.1 Inspecting Sensor Cable

If the sensor-to-analyzer interconnect cable has not been put in conduit or other protective means, it should be inspected every few months for physical damage. At the same time, disconnect cable at the sensor and instrument, and check wires for internal shorts with an ohmmeter

1.2 Checking System Periodically

Depending on the application, system calibration should be performed periodically to maintain measurement accuracy. Frequent checks are suggested until operating experience can determine the optimum time between checks that provides acceptable measurement results.

1.3 Replacing Relays

1. *Disconnect line power.* Remove display module assembly by loosening two captive fasteners and disconnecting ribbon-cable connector located to the left of TB4.
2. Unfasten four screws that hold power-supply board to bottom of instrument case. Remove power-supply board.
3. Unsolder relay from backside of power-supply board (side opposite terminal strips).
4. Replace relay with equivalent relay (GLI p/n 99X2T1016). Solder relay pins into board.
5. Mount power-supply board, connect ribbon-cable connector and install display module assembly with captive fasteners.

SECTION 2 - TROUBLESHOOTING

A few simple checks can determine if the measuring system (sensor and instrument) is functioning properly. This section is intended to isolate the problem to a particular element of the system. If the conditions for each part of this section are met, the system is verified to be operating properly. If not, Table B at the end of this section lists common symptoms and causes to aid in identifying problems.

2.1 Checking Electrical Connections

1. Verify that line power is reaching appropriate instrument terminals.

2. Push ribbon-cable connector halves together as tightly as possible. Tighten wire connections to meter display.

2.2 Checking The Instrument

1. Disconnect the sensor, place **RUN/TEST** switch to **TEST** and apply line power to the instrument.

2. Turn **TEST/OFFSET** control through its full adjustment range to make display indicate its entire scale. If this is accomplished, the instrument is operating properly but the sensor or interconnect cable (if used) may be defective. Proceed with step 3. If indication cannot be attained, the instrument is probably defective.

3. Reconnect the sensor directly to the instrument (purposely excluding interconnect cable, if used). Calibrate the system using the procedure described in Part Three, Section 4. If calibration is accomplished, the instrument and sensor are operating properly. If the system cannot be properly calibrated, the sensor is probably defective.

4. If interconnect cable is used and step 3 determines that the instrument and sensor operate properly, the interconnect cable is probably defective.

Table B - TROUBLESHOOTING SYMPTOMS/CAUSES

Symptom	Typical Causes
Display reading is zero or minimum scale value.	1. Line power is not present or connected. 2. Ribbon-cable plug from display module assembly is not properly connected into power-supply board assembly.
Display reading is constant when process value is known to be changing.	1. **RUN/TEST** switch is in **TEST** instead of **RUN**. 2. Sensor is disconnected or interconnect cable between instrument and sensor is open or shorted. 3. A ground loop problem exists. Refer to Part Four, Section 1.3 for troubleshooting details.
No current present at 4-20 mA output (terminals on TB1).	1. Jumper board, optional isolator board or pulse module is not installed on power-supply board assembly. 2. Isolator board is incorrectly installed on power-supply board assembly. 3. Defective display module assembly.

2.3 Customer Assistance

Should service, parts or assistance in troubleshooting or repair be required, please contact your GLI representative or the GLI Customer Service Department:

Great Lakes Instruments, Inc.
8855 North 55th Street
Milwaukee, Wisconsin 53223

Telephone: 414/355-3601
Telefax: 414/355-8346

When ordering spare or replacement board assemblies, be sure to use the **complete** assembly part number.

A description of the malfunction as well as the proper return address should accompany all instruments or board assemblies returned for repair, freight prepaid. All instruments or board assemblies out of warranty should be accompanied by a purchase order to cover costs of repair.

NOTE: *If the instrument or board assemblies are damaged during return shipment as a result of inadequate packaging, the customer assumes responsibility for repair costs. It is recommended to use the original GLI shipping carton or an equivalent. Also, GLI will not accept instruments returned for repair or replacement unless they are thoroughly cleaned and all process material is removed.*

RT SEVEN - SPARE PARTS AND ACCESSORIES

Description	Part Number
Program Jumpers (7 per package)	670X4A1140
Relay, 5A Contacts, 24 VDC Coil	99X2T1016
Power-Supply Board Assembly (115 V, 50/60 Hz - includes plug-in jumper board)	671M4G1001-102
Power-Supply Board Assembly (230 V, 50/60 Hz - includes plug-in jumper board)	671M4G1001-202
Plug-In Jumper Board	670A4D1004
Plug-In Isolator Board (Optional)	42B4A1001
Plug-In Pulse Module (Optional, specify maximum pulses/minute)	43M4G1001
Display Module Assembly (2 boards - includes analog meter, specify measuring scale)	671M4G2011
Analog Meter (3-1/2 inch, specify measuring scale)	99X1D1068
Optional Vertical Pipe-mount Kit	1000A4A1077
Door Assembly	1000M4G1107-102

NOTES

MICRO-BUBBLE ADDITION PROCESS PUMPS

INSTALLATION, OPERATION, MAINTENANCE
INCLUDES MECHANICAL SEAL REPLACEMENT

INSPECTION

Check pump for shortage and damage immediately upon arrival. Note damage or shortage on freight bill (bill of lading); immediately file claim with carrier.

EXTERIOR - Pay particular attention to conduit box, external hardware and accessories. Touch up abrasions or scratches with approved paint.

INTERIOR - If extensive or serious damage is noted, if impeller is damaged (look in ports), or if shaft binds or sticks, disassemble as required to permit internal inspection.

HANDLING

Handle with care. Dropping or jarring can seriously damage motor bearings or break pump parts. Lift with device having capacity of pump weight, and use lifting hooks or eye bolts (if provided) or rig double sling around motor frame and pump casing. Do not use sling through pump motor adapter nor around suction and discharge flanges.

INSTALLATION

LOCATION - Pump location should provide the following:

1. Install as close to suction supply as possible.
2. Shortest and most direct suction pipe practical. Suction lift must not exceed limit for pump. NPSH available must equal or exceed pump requirement.
3. Suction port below pumping level to provide priming.
4. Room for inspection and maintenance.
5. Correct power supply to motor; all wiring should meet National Electrical and Local Codes and regulations.
6. If outdoors, protection from the elements, freezing, and water damage due to flooding.

PIPING - Suction and discharge gauges are useful to check pump operation and are excellent trouble indicators. Install gauges in the lines if pump ports do not have gauge taps. Observe these precautions when installing piping.

1. Support close to, but independently of pump.

2. Use at least next larger pipe size for suction and discharge.

3. Keep as straight as possible, with few or no bends and fittings.

4. Remove burrs, sharp edges, ream pipe cuts, and make joints air-tight.

5. Do not spring pipe to make connections. Strain must not be transmitted to pump.

6. Allow for pipe expansion with hot fluids; expansion joints are not recommended.

SUCTION - Size and install suction piping to keep pressure loss at a minimum and to provide correct NPSH:

1. The suction pipe should be at least equal in size or preferably one size larger than the suction connection of the pump. If pipe larger than pump suction is used, an eccentric pipe reducer should be used at the pump.

2. Pipe should slope upward to pump, even for horizontal run.

3. Use 45-degree or long-sweep 90-degree elbows.

4. A valve in the suction is necessary only on positive suction head installation and must not be used to throttle the pump. The suction valve should be installed for maintenance purposes only.

DISCHARGE - Pumps permit discharge port location at any of four positions, 90 degrees apart. Change by removing cover bolts, rotate casing, and replace bolts. Do not slice o-ring or tear fibre gasket. We do not recommend bottom vertical discharge due to erratic pump performance. Ensure there is adequate clearance with selected position between wall or tank, motor conduit box and grease fittings. Casing may extend beyond base or feet.

1. If discharge line is short; size may be same as discharge port; if long, use 1 or 2 sizes larger.

2. For long horizontal runs, keep grade as even as possible; avoid high spots and loops. Trapped air will throttle flow and may result in erratic pumping.

3. Install check and gate valves in discharge line; check valve (if used) between pump and gate valve.

OPERATION

PRE-START - Before initial start of the pump, check as follows:

1. The rotation must be checked upon installation. Close, then break the contacts quickly and observe rotation of the exposed portion of rotating parts. Rotation must agree with the rotation arrow on the motor. For all pumps, the standard rotation is counterclockwise when viewed from the suction end. Motor wiring is easily changed in the field by the wiring diagram on the inside of the terminal box cover, or on the motor nameplate.

2. Check voltage, phase and frequency of line circuit with motor nameplate.

3. Check suction and discharge piping and pressure gauges for proper operation.

4. Assure that pump is full of liquid (primed).

PRIMING - If pump is installed with a positive head on the suction, prime by opening suction valve and allowing liquid to enter the casing, at the same time venting all air out of the top of the casing. If pump is installed with a suction lift, priming must be done by other methods, such as foot valves, ejectors, or by manually filling casing and suction line.

CAUTION - DO NOT RUN PUMP DRY HOPING IT WILL SELF-PRIME. Serious damage may result if started dry.

PRE-START - Proceed as follows to start pump:

1. Close drain valves and valve in discharge line.

2. Open fully all valves in the suction line.

3. Prime the pump. If pump does not prime properly, or loses prime during start-up, shut down and correct condition before repeating procedure.

4. For pumps moving high temperature liquids, open warm-up valve to circulate liquid for preheating. Close valve after pump has warmed up.

5. Start the motor (pump).

6. When pump is operating at full speed, open discharge valve slowly.

RUNNING - Periodically inspect pump while running, but especially after first start and following repair.

1. Check pump and piping for leaks. Repair immediately.

2. Record pressure gauge readings for future reference.

3. Record voltage, amperage per phase, and kw (if indicating wattmeter is available).

4. Adjust pump output (capacity) ONLY with discharge valve. DO NOT throttle suction line.

FREEZING PROTECTION - Protect pumps shut down during freezing conditions by one of the following methods:

1. Drain pump; remove all liquid from the casing.

2. Keep fluid moving in pump and insulate or heat the pump to prevent freezing. if heated, do not let temperature go above 100 to 150° F.

3. Fill pump completely with antifreeze solution.

MECHANICAL SEAL REPLACEMENT

A) Disassembly:

1. Turn off power.

2. Close suction and discharge valves.

3. Drain system.

4. Remove bolts holding down motor to foundation.

5. Remove casing bolts.

6. Remove motor and rotating element from casing, leaving casing and piping undisturbed.

7. Insert a screwdriver in one of the impeller waterway passages and back off the impeller retaining assembly with a socket wrench, as shown in Figure 1.

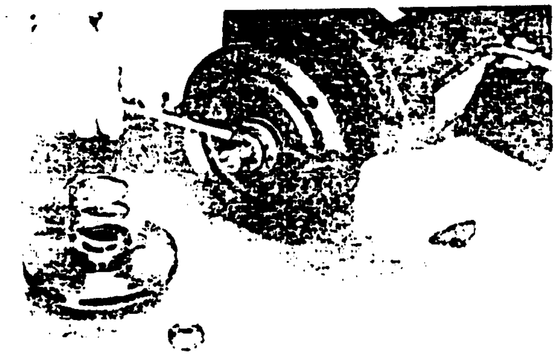


Figure 1

8. Remove impeller from shaft, being careful not to lose the impeller key, spring and seal retainer. If impeller is difficult to remove, it may be necessary to use a bearing puller to pull off impeller.

9. Pry off rotating member of mechanical seal from sleeve or stub shaft by using two (2) screwdrivers (see Figure 2).

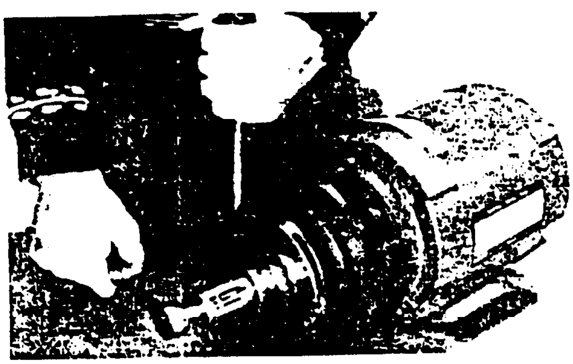


Figure 2

10. Remove bolts holding adapter to motor and take off adapter.

11. Place adapter on a flat surface and push out stationary part of mechanical seal.

12. Inspect shaft sleeve or stub shaft. If damaged or worn, remove from shaft and replace with a new one.

B) Reassembly:

1. Clean gasket and flange faces, seal seat cavity, shaft sleeve or stub shaft and motor shaft.

2. Lubricate seal seat cavity of adapter and rubber cup or o-ring of stationary seat with soapy water solution. Press stationary seat in seal seat cavity squarely and evenly, with caution not to chip or scratch the lapped face of the seat.

3. With motor preferably in vertical position, remount the adapter on motor, making sure the motor shaft does not dislocate or chip the stationary seat of the seal.

4. Apply soapy water solution to the sleeve or stub shaft and the rubber bellows of the rotary seal. Slide rotating member of mechanical seal over sleeve or stub shaft. Replace seal spring and seal retainer. Be sure the rotating seal face stays in the holding collar during installation. Also, take extra care not to chip or scratch the seal lapped faces.

5. Place key in key seat and slide impeller on shaft. Replace impeller retaining nut.

6. Insert a screwdriver in a waterway passage of the impeller holding it against rotation and tighten nut.

7. Remove any burrs caused by screwdriver on the vane of the impeller in waterway passage.

8. Slide motor and rotating element in casing. Be sure that any damaged o-ring or gasket is replaced.

9. Tighten casing bolts alternately and evenly.

10. Replace hold-down bolts.

11. Check for free rotation after assembly is completed.

12. Close all drain openings, using pipe sealant on threads.

13. Reprime before starting. Do not start unit until pump is completely filled with water.

BECKART RECOMMENDS STOCKING A SPARE MECHANICAL SEAL OR REPAIR KIT TO ELIMINATE COSTLY DOWN TIMES.

MAINTENANCE

CLEANING - Remove oil, dust, dirt, water, chemicals from exterior of motor and pump. Keep motor air inlet and outlet open. Blow out interior of open motors with clean compressed air at low pressure. Regularly drain moisture from TEFC motors.

LABELED MOTORS - It is imperative for repair of a motor with Underwriters' Laboratories label that original clearances be held; that all plugs, screws, other hardware be fastened securely, and that parts replacements be exact duplicates or approved equals. Violation of any of the above invalidates Underwriters' label.

TEMPERATURE - Total temperature, not the rise, is the measure of safe operation for a motor. If temperature by thermometer exceeds limits for insulation class, investigate and change operating conditions.

LUBRICATION - Pumps should require no maintenance, other than the motor bearings according to the following instructions:

DOUBLE SHIELDED - When double shielded prelubricated bearings are furnished, no lubrication is required for the life of the bearings. Inspect bearings periodically to determine the condition of the grease and replace the bearings if necessary.

SINGLE SHIELDED WITH GREASE FITTING PROVISIONS - When single shield bearings are furnished periodic inspection, cleaning and relubrication is required. See motor manufacturer's specific instructions for lubrication.

SCHOTT

GREAT LAKES INSTRUMENTS

OPERATING INSTRUCTION MANUAL

Manual No. 222
Revision 7-1191

ENCAPSULATED pH SENSORS

(Epoxy and Vinyl Ester Types)

Great Lakes Instruments, Inc.
8855 North 55th Street, Milwaukee, Wisconsin 53223 • (414) 355-3601 • Telex 26-9685 • Telefax (414) 355-8346

TABLE OF CONTENTS

PART ONE - INTRODUCTION

TABLE OF CONTENTS (Continued)

ILLUSTRATIONS:

WARRANTY/REPLACEMENT PLAN

Great Lakes Instruments, Inc. will replace—**free**—any sensor which fails within 1 year from the date of shipment (excluding failure due to physical breakage or damage resulting from excessive temperature). The date code, shown as a prefix in the sensor's serial number, identifies the month and year of shipment. If a GLI sensor fails for any reason—including physical damage—within 30 months, we will provide a replacement sensor at a substantially reduced price. GLI limits the warranty to replacement of the defective sensor which must be returned to the factory, freight prepaid, for examination. The sensor must be thoroughly cleaned and the process chemicals removed before it will be accepted for replacement or repair. GLI shall not be liable for any consequential damages, whether to person or property, caused by a defective sensor.

PART ONE - INTRODUCTION

SECTION 1 - GENERAL INFORMATION

1.1 Description

Electronics

The epoxy or vinyl ester-encapsulated pH sensor has either an integral preamplifier (identified by its 5-wire cable) or two-wire transmitter (identified by its 2-wire cable) which provides a 4-20 mA output. Both sensor types also have an integral temperature-sensitive resistor to automatically compensate pH measurements for temperature variations.

Mounting Styles

The encapsulated pH sensor is available in four mounting styles. The "flow-thru" mounting style sensor is threaded at the electrode end for mounting into a standard 1-1/2 inch NPT pipe tee. The "submersion" style sensor has threads on the cable end so that it can be threaded onto the end of a pipe. The "convertible" style sensor combines these first two styles by being threaded at both ends so that it can be used in either mounting arrangement. The "union-mount" style sensor has an extended, smaller diameter body on the electrode end and requires a standard 1-1/2 inch NPT union and pipe tee for installation.

1.2 Operating Precautions

1. The output of the two-wire type sensor is **non-isolated and uncalibrated.** Consequently, the measuring system's indicating instrument must be able to provide 24 VDC where low is isolated from earth ground to power the sensor and have adjustment means to calibrate for offset and span. Refer to the calibration procedure in the instrument instruction manual for details.

2. The process electrode at the tip of the sensor is glass which can easily break. Do not subject it to impact or other mechanical abuse.

   Caution: A broken glass electrode can cause serious cuts if not handled carefully.

3. Before using the sensor in extremely strong solvents such as ethylene dichloride, consult the GLI Customer Service Department.

4. pH sensors with glass electrodes must not be used in hydrofluoric acid which dissolves the glass. A sensor with an antimony electrode is recommended in this case.

5. Do not use epoxy-encapsulated pH sensors in nitric acid solutions stronger than 1% or in solutions of less than 2.5 pH.

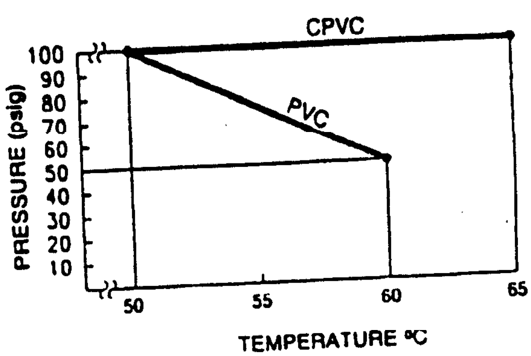
6. Before placing the sensor into operation, **remove the protective plastic caps** to expose the process electrode and "salt bridge". Save caps for future use.

   NOTE: If sensor is to be out of solution for more than a day or two, put a few drops of water in each cap and replace them on the sensor. This keeps the pH sensitive glass and salt bridge moist and avoids slow response when the sensor is put back into operation.

SECTION 2 - SPECIFICATIONS

	Epoxy Sensors	Vinyl Ester Sensors
Min. Temperature	–5°C (23°F)	–5°C (23°F)
Max. Temperature:		
In PVC Tee	60°C at 50 psig 50°C at 100 psig	60°C at 50 psig 50°C at 100 psig
In CPVC Tee	65°C at 100 psig	95°C at 40 psig 65°C at 100 psig
In Steel Tee	65°C at 75 psig 50°C at 100 psig	80°C at 75 psig 65°C at 100 psig
Maximum Pressure:		
In PVC Tee	100 psig at 50°C 50 psig at 60°C	100 psig at 50°C 50 psig at 60°C
In CPVC Tee	100 psig at 65°C	100 psig at 65°C 40 psig at 95°C
In Steel Tee	100 psig at 50°C 75 psig at 65°C	100 psig at 65°C 75 psig at 80°C

Plastic Mounting Hardware Ratings



	Epoxy Sensors	Vinyl Ester Sensors
Wetted Materials*	Epoxy body, liquid crystal polymer (LCP)salt bridge w/ PVDF junction and Viton O-ring seal.	Vinyl ester body, vinyl ester salt bridge w/PVDF junction, Viton O-ring seal, and RTV sealant.

*A glass process electrode and titanium palladium ground electrode are common to both types.

	Epoxy Sensors	Vinyl Ester Sensors
Measuring Range	4 to 10 pH	0 to 14 pH

NOTE: *Most pH applications fall in the 2.5-12.5 pH range. General purpose pH glass electrodes perform well in this range. Some industrial applications require accurate measurements and control at pH values below 2 or above 12. Consult GLI for details on these applications.*

Repeatability and speed of response for pH sensors with an antimony process electrode is not as good as those with a glass process electrode. Antimony electrodes are only linear between 3 and 8 pH and should only be specified when process conditions, such as the presence of hydrofluoric acid, dictate their use.

<u>The following specifications are common to both types:</u>

Maximum Flow Rate ..... 10 feet per second

NOTE: *If possible, flow rate should be minimal for low conductivity water or solutions high in suspended solids.*

Performance:

Sensitivity .... Less than 0.005 pH

Stability .... 0.03 pH units per 24 hrs., non-cumulative

For Sensor w/Two-wire Transmitter:

Output Span........... 0.95 mA per pH

Output Offset .... 12 mA occurs at 7.0 pH (+) or (-) 0.88 pH

Load at 20 mA .... 450 ohms

Sensor Cable:

Sensor w/
Preamplifier .... 5 conductor (plus shield), 4.5 ft. length for submersion style, 10 ft. length for all other styles

Sensor w/Two-wire
Transmitter .... 2 conductor (twisted pair), 4.5 ft. length for submersion style, 10 ft. length for all other styles

Transmission Distance:

Sensor w/
Preamplifier .... 3000 ft. maximum

Sensor w/Two-wire
Transmitter .... Limited by wire resistance and power supply voltage

PART TWO - INSTALLATION

SECTION 1 - LOCATION REQUIREMENTS

1. Mount the sensor vertically, electrodes down. If the sensor must be installed on an angle, it should be **at least 15° above horizontal**. Other mounting angles may cause erratic readings.
2. Use Teflon tape on sensor and mounting hardware threads to avoid leaks. Do not use pipe sealant.

SECTION 2 - MOUNTING

2.1 Submersion

The sensor may be submersion or tank mounted by threading it onto the end of a pipe of an appropriate length (Figure 2-1).

1. Screw a 1-1/2 inch x 1 inch NPT reducer coupling onto cable end of sensor. Route sensor cable through an appropriate length of 1-inch mounting pipe. Screw pipe into reducer coupling.
2. Run sensor cable into unilet junction box. Screw unilet box onto mounting pipe.
3. Run interconnect cable into unilet. Connect sensor and interconnect cable wires, by matching colors, to terminal strip in unilet. Fasten cover onto unilet.
4. Route interconnect cable to instrument. If cable is too long, cut it to proper length to avoid any interference from inductive pick-up. It is recommended to run this cable in 1/2" or larger flexible, metal conduit for protection against moisture and mechanical damage. Flexible conduit must be long enough to allow removal of the sensor from the process for maintenance and calibration.

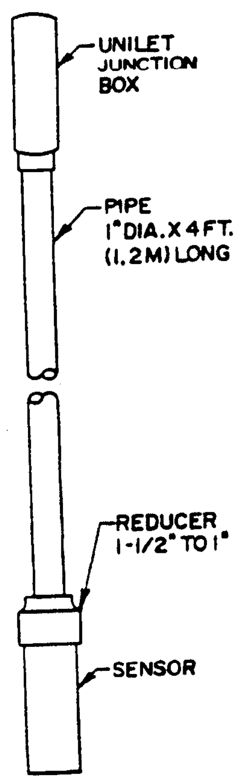


FIGURE 2-1
Submersion Mounting Details

NOTE: Do not run this cable in the same conduit with power or control wiring ("electrical noise" may interfere with sensor signal).

5. Connect interconnect cable wires to instrument in accordance with instrument hook-up instructions.

6. Remove protective plastic caps from sensor and save for future use. Calibrate system with pH buffers using the procedure in the instrument instruction manual before mounting sensor/hardware assembly into the process.

7. Fasten electrode protector onto end of sensor. Mount sensor/hardware assembly by suitable means. This completes the submersion installation.

2.2 Flow-Thru (Pipe Tee)

The sensor may be tee mounted by threading it into a standard 1-1/2-inch NPT pipe tee (Figure 2-2)

1. Install a standard 1-1/2 inch NPT pipe tee into the process line.

2. Electrically connect the sensor directly to the instrument or indirectly with a junction box and interconnect cable.

   A. Direct Hook-Up

      a. Route sensor cable to instrument. Use a watertight connector, such as a cable feed-thru fitting, in the instrument's cable entry hole.

      b. Connect sensor cable wires to instrument in accordance with instrument hook-up instructions.

   B. Indirect Hook-Up With Junction Box

      a. Mount junction box (with terminal strip) on a flat surface such that its cover is removable when installed.

      b. Route sensor cable to junction box through a watertight connector such as a cable feed-thru fitting.

         NOTE: Keep terminal strip dry to prevent problems caused by wet and/or corroded terminals.

      c. Route interconnect cable from junction box to instrument. If cable is too long, cut it to proper length to avoid any interference from inductive pick-up. It is recommended to run this cable in 1/2" or larger metal conduit for protection against moisture and mechanical damage. Use conduit hubs where cable enters the junction box and instrument enclosure.

NOTE: Do not run this cable in the same conduit with power or control wiring ("electrical noise" may interfere with sensor signal).

d. Connect sensor and interconnect cable wires, by matching colors, to junction box terminal strip. Fasten cover onto junction box.

e. Connect interconnect cable wires to instrument in accordance with instrument hook-up instructions.

3. Remove protective plastic caps from sensor and save for future use. Calibrate system with pH buffers using the procedure in the instrument instruction manual before mounting sensor into the process line.

4. Purposely pre-twist the sensor cable by turning the sensor counterclockwise (left) 4 to 5 turns. Now place sensor into tee and hand tighten. Use a strap wrench (not a pipe wrench) on the sensor body to carefully snug the connection to prevent leaks. **Do not overtighten!** This completes the pipe tee installation.

2.3 Union

The union-mount style sensor is installed by using a standard 1-1/2 inch NPT pipe tee and union coupling (Figure 2-3).

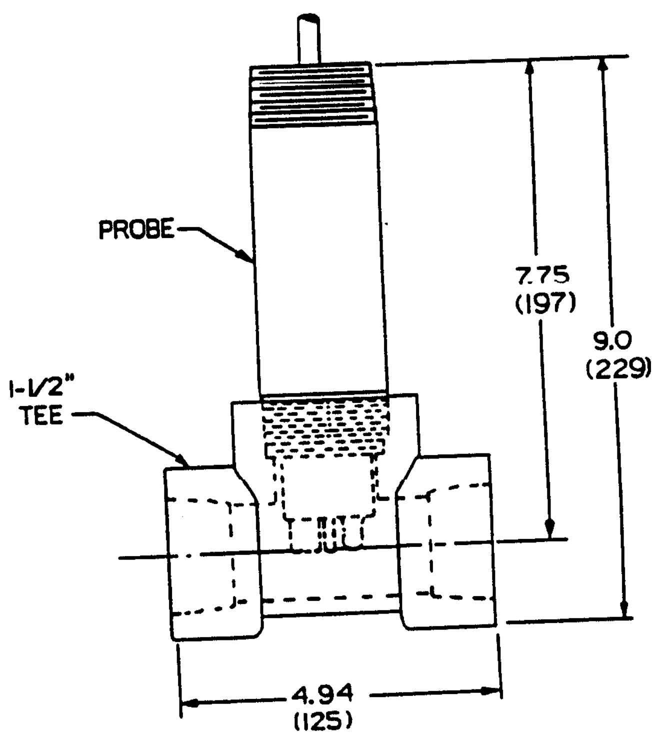


FIGURE 2-2 Tee Mounting Details

1. Install a standard 1-1/2-inch NPT pipe tee into the process line.
2. Screw a 1-1/2 inch NPT close nipple into the tee.
3. Fasten externally-threaded section of union onto close nipple.
4. Remove protective plastic caps from sensor and save for future use. Screw sensor into union-half with O-ring seal.
5. Route sensor cable through union lock ring and electrically connect sensor to instrument as described in Section 2.2, step 2A or 2B.
6. Calibrate system with pH buffers using the procedure in the instrument instruction manual before mounting sensor into the process line.
7. Carefully place sensor into tee and align mating union half surfaces. Make sure O-ring is properly seated and hand tighten union lock ring. This completes the union-mount installation.

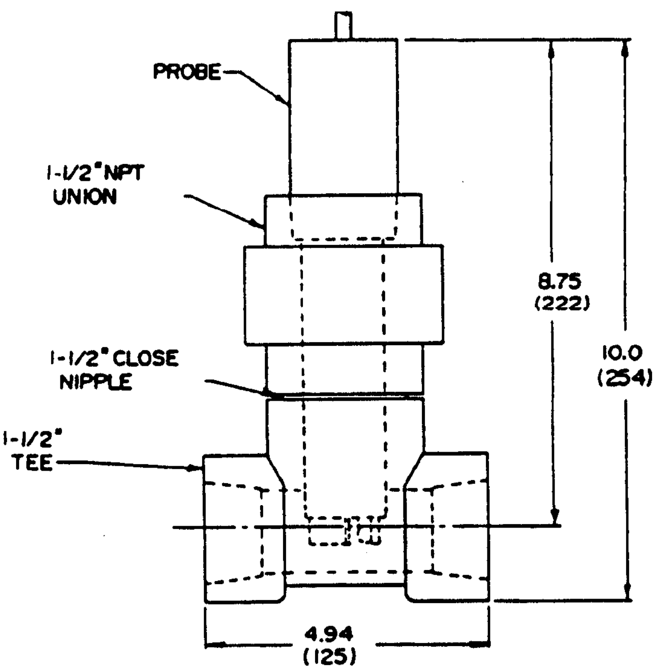


FIGURE 2-3 Union Mounting Details

PART THREE - PRINCIPLE OF OPERATION

The sensor operates in principle as if it contained two "batteries" whose voltages are measured and transmitted by electronic amplifiers. One battery is formed by the ground electrode and the glass process electrode. The voltage of this battery is a function of the solution pH. The other battery is formed by the same ground electrode and the standard electrode which contains a pH electrode in a chemical standard of fixed pH value (see Figure 4-1). The voltage of the second battery is subtracted from the voltage of the first battery. The result is a differential pH measurement, the final signal being that of a pH electrode in the process compared to a pH electrode in a chemical standard solution.

A temperature sensitive resistor inside of the sensor automatically compensates the pH measurement for temperature variations by adjusting the output of the sensor.

PART FOUR - SERVICE AND MAINTENANCE

SECTION 1 - RECOMMENDED CLEANING PROCEDURE

The sensor must be kept reasonably clean to maintain measurement accuracy. The time period between cleanings (days, weeks, etc.) is affected by the characteristics of the process solution and can only be determined by operating experience. For example, a sensor operating in waste water that contains oil and/or grease may require more frequent cleaning.

1. Rinse the sensor with clean, warm water.
2. Prepare a mild soap solution. Use warm water and dishwashing detergent or other non-abrasive soaps that do not contain lanolin which will coat the glass process electrode.
3. Soak the sensor for 2 to 3 minutes in the soap solution.
4. Using a **soft** bristle brush, scrub the entire measuring end of the sensor (glass process electrode, salt bridge and ground electrode).

   CAUTION: Performance can be degraded by scratching the glass electrode. Do not use a cleaning brush that can cause scratches.